NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

VOL. 179, NO. 4558 SATURDAY, MARCH 9, 1957 2s 6D.

The key to your circuit problems

"METROSIL"
is a non-ohmic resistance having the characteristic CURRENT ∝ (VOLTAGE)^4.

Some proved uses are in :
SURGE SUPPRESSION · LIGHTNING ARRESTERS · VOLTAGE REGULATION · FIELD CONTROL · SPARK SUPPRESSION · RADIO CIRCUIT PROTECTION

Send for leaflet NO. 220/1-1

METROPOLITAN-VICKERS ELECTRICAL Co. Ltd., Manchester, 17
Member of the A.E.I. group of Companies MM/601

Tinsley
STANDARD CADMIUM CELLS

Single and double types in wooden cases or in metal cases as illustrated.

Reliable single or double miniature types mounted in plastic cases, E.M.F. 1.01859 abs. volts at 20°C. Temp. coeff.—40 μV/1°C. Low internal resistance.

Dimensions 3$\frac{1}{2}$ in. × 1$\frac{3}{8}$ in. × 1$\frac{3}{16}$ in.

Non-temperature coefficient cells for industrial use.

All types of unmounted standard cells can be supplied in quantity from stock.

H. Tinsley & Co. Ltd., Werndee Hall
London, S.E.25
Telephone : ADDiscombe 6046-7-8

For projection perfection . . .

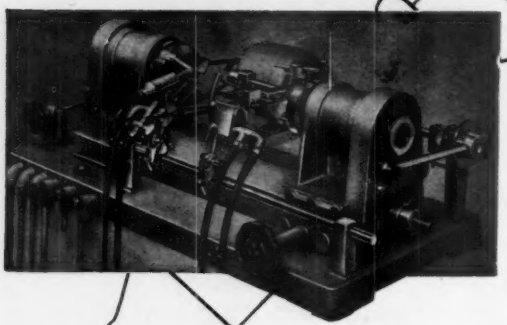
. . . the 'British' Epidiascope is fitted with silent twin cooling fans and has a large specimen platform in an undercarriage which is easily interchanged with a castor mounting for movement over unlimited areas. A simple lever movement selects either epi- or diascopic projection through the same lens and without change of focus.

Price £116 12*s.* 0*d.*, *ex Works*
Immediate delivery—write now for illustrated list

The 'British' Epidiascope

C. Baker OF HOLBORN LTD EST 1765

C. BAKER OF HOLBORN LIMITED
METRON WORKS · PURLEY WAY · CROYDON SURREY
CROydon 3845/6/7



10,000 'Tailor-made' GLASS PARTS INSIDE A WEEK?

—it would have been impossible . . .

without the development of the "SPEEDIVAC" CAPSTAN-TYPE GLASSWORKING LATHE.

For single pieces or 10,000 repetitions—every one precision-made and interchangeable—its economy is only surpassed by its simplicity of operation—for any apprentice can quickly master the "SPEEDIVAC" G.3.

EARLY DELIVERY

For better vacuum service . . .

EDWARDS HIGH VACUUM LTD

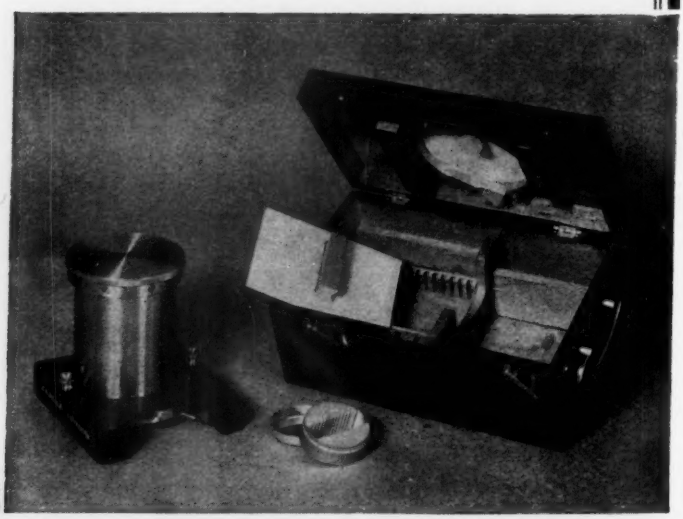
MANOR ROYAL · CRAWLEY · SUSSEX CRAWLEY 1500 (10 LINES) EDCOHIVAC CRAWLEY

CASELLA LONDON

SETTLEMENT DUST COUNTER

Suitable for large dust particles or airborne bacteria

Size in case 10 × 6 × 4½ in. (25 × 15 × 12 cm.) 9½ lb. (4·2 kg.)



AVAILABLE FOR IMMEDIATE DELIVERY

Write for leaflet No. 778

C. F. CASELLA & CO. LTD.
REGENT HOUSE
FITZROY SQUARE
LONDON, W.1

Telephone: ★EUSton 3944

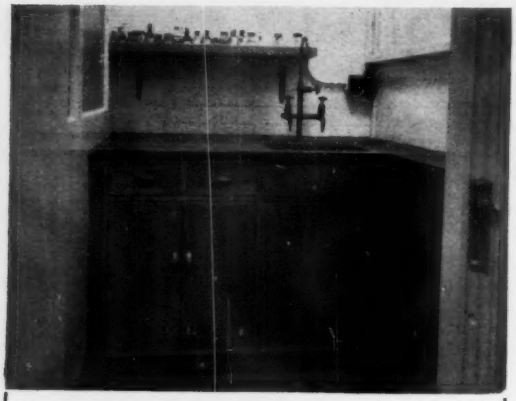
Member Scientific Instrument Manufacturers' Association of Gt. Britain

NATURE

No. 4558 SATURDAY, MARCH 9, 1957 Vol. 179

CONTENTS

	Page
Security and Loyalty	497
Nuclear Engineering. By Dr. H. Kronberger, O.B.E.	499
Electrical Fishing in Germany. By W. G. Hartley	500
Neanderthal Man. By Sir Wilfrid Le Gros Clark, F.R.S.	501
Technology of Thin Films. By Dr. A. H. Jarrett	501
The Human Lymphatic System. By Prof. W. J. Hamilton	502
Zoology Expands. By Dr. Edward Hindle, F.R.S.	502
Plastic Methods of Structural Analysis. By Prof. W. F. Cassie	503
Progress in Chemical Engineering. By Dr. J. F. Richardson	503
Mechanical Vibrations. By R. E. D. Bishop	504
What is Tea ? By W. Wight and P. K. Barua	506
The Midlands Earthquake of February 11, 1957. By Dr. A. T. J. Dollar	507
Obituaries:	
Dr. J. von Neumann. By Sir William Penney, K.B.E., F.R.S.	510
The Marchese Solari	510
Mr. James Wright. By R. V. Melville	511
News and Views	511
Scientific Research and its Organization. By A. R. Weyl	517
Examination of London Waters. By Dr. B. A. Southgate, C.B.E.	518
Regional Advisory Councils for Technical and Further Education in Britain. By T. H. Hawkins	518
Instrumentation in Science	519
Agricultural Meteorology in Germany. By G. A. Bull	519
Radiosensitive Molecular Weight of Tobacco Mosaic Virus Nucleic Acid. By Dr. William Ginoza and Prof. Amos Norman	520
Radiochemical Degradation of DL-Methionine. By Jaroslav Kolousek, Jindrich Liebster and Arnost Babicky	521
A Preliminary Analysis of the Stroboscopic Patterns. By J. R. Smythies	523
Letters to the Editors:	
'Electro-Chemical' Orientation of Bracken Spermatozoids.—C. J. Brokaw	525
Evidence for Subcortical Regulation of the Afferent Discharge to the Somatic Sensory Cortex in Man.—Dr. K.-E. Hagbarth and S. Höjeberg	526
Effect of Temperature on the Degeneration of Nerve Fibres.—H. J. Gamble, Prof. F. Goldby and G. M. R. Smith	527
Swelling of Fibrous Proteins.—Prof. John L. Morrison and James F. Hanlan	528
Revealing of Surface Texture by Metal Deposition.—V. R. Guru Moorti and Dr. M. K. Gharpurey	529
Variation in the Lignin laid down by *Eucalyptus regnans* at Different Stages of Growth.—David E. Bland and B. Hirnyj	529
Grass Pollen Constituents: the Meso-inositol Content.—R. Augustin and D. A. Nixon	530
Occurrence of Shikimic Acid in Gooseberry Fruits.—Dr. G. C. Whiting	531
Decrease of Phosphorus/Oxygen Ratios by Dinitrophenol *in vivo*.—Dr. Mario U. Dianzani and Mrs. Maria Assunta Dianzani Mor	532
The Antihæmophilic and Christmas Factor Activities of Ethanol Fractions of Brain Extract.—Dr. F. Nour-Eldin and Dr. John F. Wilkinson	532
Hyponitrite Reductase in *Neurospora*.—Dr. Antonia Medina and Dr. D. J. D. Nicholas	533
Inhibition of Alanine Transaminase by the Hypoglycæmic Sulphonylurea Derivatives.—J. Bornstein	534
The α–β Transformation in Keratin.—E. G. Bendit	535
Structure of Bacitracin A.—Dr. Dorothy Wrinch	536
Microbiological Degradation of Cholic Acid.—Shohei Hayakawa, Takao Fujii, Yasuo Saburi and Takeo Eguchi	537
Enzymatic Synthesis of N-Glucuronic Acid Conjugates.—Julius Axelrod, Joseph K. Inscoe and Gordon M. Tomkins	538
Effect of the Interaction between Chelating Agents on their Fungitoxicity.—Dr. R. J. W. Byrde and D. Woodcock	539
Radiolysis of Tri-*n*-butyl Phosphate.—T. F. Williams, R. W. Wilkinson and T. Rigg	540
Dispersion of the Photoelastic Constants of Fused Silica.—E. S. Jog and Prof. R. S. Krishnan	540
Ionization Gauge Detector for Gas Chromatography.—S. A. Ryce and Prof. W. A. Bryce	541
Infra-red Spectra of High-temperature Phases of Kaolinite and Halloysite.—Dr. V. Stubican and Hs. H. Günthard	542
Density of Marine Benthic Communities off West Africa.—Alan R. Longhurst	542
A Root Disease of *Piper nigrum* L. in Sarawak caused by a Species of *Phytophthora*.—Paul Holliday and W. P. Mowat	543
A Morphologically Distinct Ecotype of *Dactylis glomerata* L.—Dr. Martin Borrill	544
Nature of Chalk Heath Soils.—Dr. A. S. Thomas; Dr. R. M. S. Perrin	545
Identification of Coffinite in Radioactive Rocks of the Buller Gorge Region, New Zealand.—J. J. Reed and G. G. Claridge	546



LABORATORY EQUIPMENT

PRECISION BUILT BY
DISABLED SOLDIERS, SAILORS
& AIRMEN TRAINED AS CRAFTSMEN

Laboratory Benches ; Stools ; Tables ; Chemical Cupboards ; Fume Cupboards ; Benches can be supplied with spirit-resisting tops.

LORD ROBERTS WORKSHOPS
Meadowside Dundee

CHARLES GRIFFIN & COMPANY LTD
Established 1820

Just Published *Second Edition*

PROCESS & PHYSICAL METALLURGY

By J. E. GARSIDE, M.Sc.Tech., Ph.D.
Assoc. M.C.T., F.R.I.C., F.I.M., M.Inst.F. Principal: The Borough Polytechnic, London

This is a new and revised edition of a book written to meet the needs of those studying metallurgy from the standpoint of the user of metallic materials, and the whole field—theoretical metallurgy and complementary subjects—is presented in one volume. For the practising metallurgist, engineer, or student, it is of inestimable value to have information on such subjects as fuels, refractories, furnaces, moulding materials, pyrometry, mechanical deformation, heat treatment, and the joining of metals, arranged in correct relationship and to the right extent with the theoretical aspects of metallurgical science. Apart from the revision of existing text, two new chapters have been incorporated—on powder metallurgy and on the corrosion of metals and alloys, respectively. It is a most suitable book for those taking courses in metallurgy or engineering metallurgy leading to the engineering and metallurgical degrees of the Universities, the Higher National Certificate in Metallurgy and in Engineering, the new "Dip.Tech. (Eng.)," and other examinations of comparable standard.

600 pages (9" × 6"). 243 illustrations.
Price 54s. net.

42 DRURY LANE · LONDON · W.C.2

PRISM SPECTROSCOPE

This adjustable slit spectroscope with a dispersion (h to b) of 14 degrees 25 minutes is one of the items in our range of instruments designed for the identification of gem stones.

The range includes refractometers, microscope, dichroscope, polariscopes, etc.

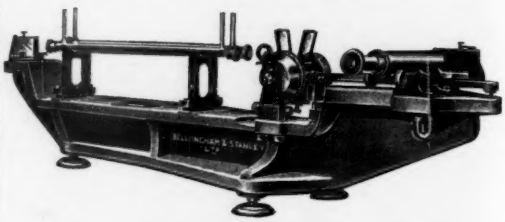
We shall be pleased to send illustrated particulars of the spectroscope or the full range of equipment.

•

RAYNER
100 NEW BOND STREET, LONDON, W.1
Telephone GRO 5081

PRECISION INSTRUMENTS

Jamin Refractometer
for liquids or gases



Average accuracy in measurement of refractive index is approximately 0.000001 for gases and 0.000002 for liquids.

The elimination of all spring adjustment to the mirrors results in great stability and freedom from vibration. Worm wheel gearing actuates the compensator. Tubes up to 50 cm. length can be used.

Bellingham & Stanley Ltd.
DEPT. N, 71 HORNSEY RISE, LONDON, N.19
PHONE: ARCHWAY 2270

SECURITY AND LOYALTY

IN a debate in the House of Commons on November 7, 1955, Mr. Harold Macmillan, who was then Secretary of State for Foreign Affairs, said that since 1945 a check had regularly been made on all new entrants into the Foreign Office and on all new temporary employees, to ensure that no adverse security record was held against candidates for employment. Nevertheless, it had been recognized that something more than this negative check is required to ensure the reliability of those holding important positions in the public service. At the beginning of 1952, therefore, a regular system of positive inquiry was introduced in all Government departments having access to classified material involving the security of the State. This procedure involves detailed inquiry into the whole background of the officer concerned, including his school and university career and any previous employment before joining the Service, frequently including personal inquiries of university tutors, past employers and others with personal knowledge of the candidate.

These inquiries were the subject of discussion at a recent meeting of the Council of the Association of University Teachers, when after long debate the Council decided to protest against the questions the Government asks about the religious and political beliefs and activities of students. While affirming that university teachers ought not to be asked such questions, the Council did not refuse to co-operate, stating that whether or not such questions were answered is in the last resort a matter for personal decision by the individual. There was, however, almost unanimous support for a further resolution that such questions should not be answered without the knowledge of the student concerned.

No one at the meeting of the Association of University Teachers appeared to doubt that such questions would continue to be put, and some at least recognized that there is a real problem of security, responsibility for which cannot be placed on others. Non-co-operation by the universities would only mean that the Government would have to satisfy itself in other ways before the students concerned could be considered as candidates for employment. The security checks had the firm support of the committee appointed by Mr. Herbert Morrison, when he was Foreign Secretary, to look into all aspects of the security arrangements of the Foreign Service, and they were further approved by the Conference of Privy Councillors set up in November 1955 "To examine the security procedures now applied in the public services and to consider whether any further precautions are called for and should be taken".

A White Paper giving the substance of the report of the Conference was published in March 1956, and included a number of specific recommendations. The report includes a close examination of the security procedures in the public services in Britain, and accordingly the Prime Minister stated on November 29, 1955, that it would not be in the public interest to publish the full text of the report or to make known all its recommendations. The White Paper, however, records the main conclusion of the Conference that there is nothing organically wrong or unsound about the Government's security arrangements, although certain recommendations are made to strengthen the system in some respects.

The Government proposes to adopt all these recommendations, one of which was that the tribunal (commonly known as the 'Three Advisers') set up in 1948 to hear appeals from Civil servants threatened on security grounds with transfer from secret duties or with dismissal from the Service should be continued, but that its terms of reference should be widened so as to enable the tribunal to present a fuller report to the responsible Minister. The Conference, moreover, was convinced that in deciding the difficult and borderline cases it was right to continue the practice of tilting the balance in favour of offering greater protection to the security of the State rather than in the direction of safeguarding the rights of the individual. The measures necessary to give effect to the Conference recommendations involved alterations in existing procedures which were notified to the staff associations concerned, and the alterations were only promulgated in full after an opportunity for representation had been given.

Details of the revised procedure to be followed when the reliability of a Civil servant, the nature of whose work is vital to the security of the State, is thought to be in doubt on security grounds were given in a written answer to a question in the House of Commons on January 29, 1957. A further question by Mr. W. Griffiths regarding security checks in the Department of Scientific and Industrial Research on February 5 also brought the subject into prominence. The sixth annual report of the National Science Foundation, of Washington, D.C., also includes a statement relevant to the whole subject. It may well be helpful, therefore, not only to universities in Britain but also to those in other countries such as South Africa and Australia, where current questions of academic independence and loyalty have also arisen in a context involving, or so presented as to appear to involve, the security of the State, to indicate briefly the way in which the problem is being handled in Great Britain.

Replying to Mr. G. Finlay on January 29, the Financial Secretary to the Treasury, Mr. J. Enoch Powell, said that, under the revised procedure, the Minister responsible for the Department to which the Civil servant belongs will have before him information on which to decide whether there is a *prima facie* case on reasons of security for doubting the reliability of that Civil servant. The grounds for such doubts are present or recent membership of the British Communist Party or sympathy with Communism,

association with Communists or Communist sympathizers, or susceptibility to Communist pressure. Each case will be assessed in the light of the particular facts, and if the Minister is satisfied that there is a *prima facie* case the Civil servant will at once be informed and will normally be sent on special leave with pay, care being taken so far as possible to avoid disclosing the reasons for his absence to his colleagues. At the same time, he will be given such particulars of his alleged membership or sympathy as might enable him to clear himself, and he will be asked to accept or deny the allegation. The Minister will reconsider the position in the light of any representations the Civil servant may make, and if there seems no reason for varying the ruling, the Civil servant will have opportunity to ask for a hearing by the 'Three Advisers', who may also receive testimony from third parties as to his record, reliability and character. Cases of character defects will not be referred to the tribunal if there is no suggestion of Communist or Fascist associations or sympathies; such appeals will be dealt with under the normal disciplinary procedure of departments. If the report of the 'Three Advisers' is adverse, the Civil servant will still have an opportunity of making representations to the Minister or his representative before action is finally taken. If the *prima facie* ruling is finally upheld, various courses may be taken: the Civil servant may be posted to, or retained in, a non-secret branch within his own Department, or posted to a non-secret branch in another Department; or he may be dismissed, unless he accepts the option of resigning. But in any event, his staff association will be afforded an opportunity of suggesting an alternative or possible re-posting.

It has not been suggested that the procedure is such as to avoid all mistakes; but it is very clear from the several statements and debates in Parliament and from the White Paper that Ministers are well aware that every doubtful action they may take —and probably some correct and thoroughly justified ones—will be challenged by one or more of the numerous bodies which in Britain are vigilant to prevent any breach of civil liberties. The soundness of the Government's policy, set forth in the revised terms of reference to the 'Three Advisers', which Mr. Powell also quoted, is not to be disputed. No one coming within the limits laid down in the White Paper ought to be employed in connexion with work vital to the security of the State. The best safeguard against abuse of the powers taken by the Government may well lie not in rules but in Ministers' knowledge of the vigilance with which their actions are being scrutinized, and in the unofficial checks and balances which an alert public conscience has caused to be built up.

There is a further and by no means negligible factor to which Dr. Arthur H. Compton directed attention in one of the most valuable passages in his recent book "Atomic Quest". In that personal narrative of the way in which he and his colleagues were drawn, sometimes most reluctantly, into the development of the atom bomb, Dr. Compton notes the secrecy which scientists imposed on themselves long before its necessity or even desirability was appreciated in official circles, and the efficiency with which security measures in the main operated, partly through the tact and understanding of the security officers themselves and partly through the loyal co-operation which the concern and understanding of the scientists involved elicited. The effectiveness of a security system depends in the end on the extent to which its necessity is understood and accepted by all affected, and their willingness to co-operate to achieve a vital public purpose.

The statement which Mr. Powell made in the House of Commons on January 29, like the White Paper issued last March, could well help to that end by displaying the care with which the Government is seeking to reconcile the needs of public security and the claims of the individual. Afterwards, on February 12, Mr. Powell said that the same procedure would be applied to employees of contractors engaged on secret Government contracts. Scientists are rarely involved in the Foreign Service, but in the field of defence and in the Atomic Energy Authority they may well be affected in increasing numbers by a need for stringent security precautions greater than elsewhere. Moreover, the difficult question of the relation between security risks and defects of character cannot be ignored. To-day greater importance must be attached to such defects as factors which may tend to make a man unreliable or expose him to blackmail or influence by foreign agents. Quite apart from political considerations, government departments cannot evade a duty of informing themselves of serious personal failings of members of their staffs that may seriously affect a man's reliability.

The reply which the Parliamentary Secretary to the Ministry of Works, as representing the Lord President of the Council, gave to Mr. W. Griffiths on February 5 shows that the number of scientists affected by security checks is not large. For the great majority of appointments to the Department of Scientific and Industrial Research, Mr. H. Nicholls said, no security check is necessary; but such a check is made where the candidate is to be employed in ports in a sensitive area. It is not the practice to inform candidates if only a negative check is carried out; and Mr. Nicholls rejected as unfounded the assertion that security officers in the course of their inquiries had unnecessarily destroyed the reputation of completely innocent people.

Last year in the United States, at the request of Governor Sherman Adams, assistant to President Eisenhower, Dr. Detlev Bronk, president of the National Academy of Sciences and chairman of the National Science Board, appointed a committee to survey the whole question of loyalty in relation to Government support of unclassified research. The recommendations of this Committee are given in the current report of the National Science Foundation. They are in line with the policy which the Foundation adopted early in its career and which was endorsed by the American Association for the Advancement of Science in December 1954. Moreover, the principles embodied

in the recommendations of this committee have already been acknowledged by Governor Adams as a satisfactory basis for action regarding grants or contracts for unclassified scientific research; and he added that departments and agencies would follow practices consistent with these recommendations. The test in the award of U.S. Government grants and contracts for unclassified research will accordingly be the scientific integrity and competence of the individuals responsible for carrying out the research, and the scientific merits of their programme. When an official of the Government comes into possession of evidence which in his opinion indicates the possible existence of disloyalty amounting to violation of law, he is expected to refer that information promptly to the Federal agencies established to enforce the law in such matters. An allegation of disloyalty is not by itself to be grounds for adverse administrative action on a grant or contract for unclassified research by scientifically competent investigators; if, however, the indications of disloyalty appear sufficiently serious to warrant action, the Government, in the opinion of this Committee, should bring formal charges and produce the evidence in open hearing before legally constituted authority.

It is thus obvious that, even in the field of unclassified research, responsible opinion, while holding to the vital criteria of scientific integrity and competence, is prepared to support inquiry into loyalty, although there may be no direct consideration of secrecy. There appears to be no support for the refusal to face the vital issue of national security which characterized the majority of those present at the meeting of the Association of University Teachers referred to earlier, and this is the more noteworthy in that the positive conception of security, expounded so ably by such men as Commager and Hutchins, MacIver, Gellhorn and Barth, has consistently marked the policy of the National Science Foundation.

While the reality of the security problem cannot be denied, there appears to be no reason for excessive concern either in the United States or in Britain. The Government measures are reasonable and do not go beyond the minimum necessary if the Government is not to be open to the charge of negligence. At the same time, the effectiveness of those measures rests rather in the spirit in which they are administered, and on the extent to which they command the support and co-operation of the great body of citizens, as was seen in some of the war-time responses on the Clyde and elsewhere mentioned by Dr. Compton in "Atomic Quest". Similarly, the real safeguard for the individual lies in the vigilance exercised by his professional associations and the various bodies concerned with the protection of civil liberties.

None the less, that vigilance must be exercised with restraint and with a greater sense of proportion than was sometimes evident in the discussion at the Council meeting of the Association of University Teachers. There are too many real and major threats to civil liberty and academic freedom in the world to-day for time and energy to be wasted in the defence of positions which do not command the general support of informed opinion. Sense as well as sensitiveness is essential, for security and also for the defence of liberty. Moreover, the ultimate safeguard for both lies in just such a positive conception of security as informs the policy of the National Science Foundation and the many defenders of academic freedom in the United States. In Britain, that doctrine has perhaps been less freely expounded though none the less tenaciously held. What is needed most is that the positive conception of security and academic freedom and the implications of that conception, for the Government and for the individual or corporate bodies such as the universities, should be thought out clearly, and expounded carefully and widely. Then the unofficial checks and balances will operate so effectively that official action will rarely if ever be required. Vision, sense and vigilance are the ultimate safeguard of individual and State.

NUCLEAR ENGINEERING

Progress in Nuclear Energy

Series 4: Technology and Engineering—Reactor Coolants, Moderators, Heat Transfer, Reactor Chemistry and Corrosion of Reactor Materials. Edited by R. Hurst and S. McLain. Vol. 1. Pp. xiii+420. (London: Pergamon Press, Ltd., 1956.) 84*s*. net.

THE production of a series of books on the progress in nuclear energy is a formidable task; the amount of material is so large and progress all over the world so rapid that the time required for the preparation of the books becomes an important factor. It is, therefore, gratifying to see that the editors have succeeded in preparing a fairly well-balanced and comparatively up-to-date survey. The volume comprises sections on heavy water, graphite, beryllia, liquid metals, engineering, reactor chemistry and corrosion. These consist mostly of a selection of papers presented at the Geneva Conference; it is unfortunate that none of the relevant criticism and discussions of the papers has been included in the present volume.

The survey of heavy water production processes by Benedict in Chapter 1 probably still remains the most complete description of this topic. The article is weighted towards water distillation and Trail processes; it appears, however, that for production on the scale demanded by a large power programme (heavy water moderated reactors require about 1 tonne of D_2O per MW. electrical capacity) these processes are not as attractive as the dual temperature H_2O/H_2S (Spevack) method. Security restrictions probably prevented the Spevack process being treated in detail. For the reader not familiar with the cascade theory of isotope plants, reference to K. Cohen's excellent book would have been justified. It is clear that the manufacture of heavy water is a major industrial undertaking; it would have been useful to the British reader if the cost figures of Table 14 had been recomputed in terms of typical British cost assumptions, and if some general cost estimates had been given in Table 15.

The British nuclear power scheme is based on graphite rather than D_2O as the moderator; tens of thousands of tons will be required every year. An

up-to-date survey of the manufacture and properties of this important material is given in Chapter 2; it forms an excellent introduction to a little-known field. Incidentally, the units for Young's modulus (in Table 9, p. 73) should be 10^6 lb./sq. in.

The use of liquid sodium and sodium–potassium as coolants is by now well established; Chapter 4 (liquid metals) could therefore have been extended to give more details of modern practice. The reviewer agrees with the statement that the cleaning of large sodium plant by steam presents problems; he is, however, concerned lest the reader be left with the impression that the alternative cleaning method described in some detail, namely, filling the plant with liquid ammonia, is preferable. The complications, costs and hazards involved in cleaning a large reactor with liquid ammonia are not likely to make this method attractive to the nuclear engineer whose aim is to produce electricity cheaply and safely. The cost of a safe sodium–water heat exchanger is an important item in estimating the cost of electricity to be produced by a sodium-cooled reactor; it is therefore felt that the relevant section (p. 156) treats the subject very lightly.

Chapter 5 (engineering) is confined to liquid metal pumps and heat transfer. The article by Barnes on liquid metal pumps is lucid but by now not comprehensive. The designer is to-day faced with a great variety of liquid metal pumps and is in need of a more critical survey of their relative advantages and applications. The account of mechanical pumps for a wide range of fluids (Ford) is methodical and gives an excellent classification of the multitude of specialized pumps which are at present being developed for nuclear plant applications.

Of the papers on the topic of heat transfer, those by Roberts and by Lyon are in the nature of reviews of the literature. M. A. Mikheyev *et al.* present heat transfer data for a number of molten metals flowing inside a pipe of circular cross-section. They attribute differences between experimental data and theories based on heat transfer–momentum transfer analogies (originally applied to liquid metals by Martinelli) to the fact that there is a conduction process superimposed on the macroscopic mixing process in turbulent flow; while they claim good agreement with a theory which takes account of this fact, they do not give details of the theory. Experimental heat-transfer data for sodium and sodium–potassium alloy are presented in a paper by W. B. Hall; quite close agreement with the Martinelli theory is found, but significant temperature variations around the circumference of a double annulus heat exchanger were detected. These unexpected, but important, results are attributed to quite small variations in the width of the annuli, and an approximate theory of the effect is presented.

The cooling system of the Saclay Pile is described in a paper by J. Yvon. The author goes on to discuss the prospects for gas cooling in future reactors; unfortunately the treatment is sketchy, and the conclusions, so far as the choice of optimum coolant temperature is concerned, appear to be incorrect.

A number of excellent articles deal with reactor chemistry and corrosion, entirely concerned, however, with aqueous and liquid metal systems. The chemical problems of gas-cooled reactors are much simpler—a fact which weighed heavily in the choice of reactors for the British power programme—and it is hoped that they will be discussed in a subsequent volume.

Developments of nuclear technology have far-reaching effects well outside their immediate field of application; the present volume will, therefore, be useful not only to those directly concerned with nuclear engineering, but also to those who wish to be kept informed on the progress of a rapidly expanding industry.

H. Kronberger

ELECTRICAL FISHING IN GERMANY

Handbuch der Binnenfischerei Mitteleuropas
Herausgegeben von Dr. R. Demoll und Dr. H. N. Maier. Ergänzungsband zu Band 5, Lieferung 3: Die Elektrofischerei. Von H. W. Denzer. Pp. viii + 141–234. (Stuttgart: E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), 1956.) 30 D.M.

Papers on electrical fishing have been appearing in many languages for the past thirty years, but Dr. H. W. Denzer's monograph is the first practical manual on the subject. Individual aspects of the process have been intensively studied; the electrophysiological basis is familiar if not complete, the reactions of fish to definite electric fields have been investigated repeatedly in connexion with the design of electrified screens to restrict their movements, and the purely physical and engineering problems may be regarded as settled. Unfortunately, the abundant literature has never been of any noticeable help in the actual capture of fish, for the published accounts are almost always written either by scientists who are not fishermen, or by fishermen who are not scientists. Consequently, while many papers deal with exact experiments in conditions not found in Nature, the rest are concerned with practical applications in partly specified circumstances, and the result is a mass of contradictory statements which may all be true in special cases.

Dr. Denzer covers the subject from its physiological basis to its administrative control, and has assembled into a single treatise the information disseminated through a vast range of more or less inaccessible journals of varying authority. He starts by explaining the concept of body-voltage, and the different degrees of reaction recognizable as this is increased or modulated, and goes on to discuss the effect of water conductivity on the distribution of the electric field in and around the fish, and the variations found in typical streams. There follow an analysis of the practical requirements for catching fish, and the German regulations governing the construction and use of the apparatus. The application of electrical methods and the techniques to be used in different conditions are treated in some detail, and descriptions and illustrations provided of various generating units and electrodes employed in Germany and Switzerland.

It is a pity, though very natural, that the book should be so exclusively addressed to a German audience. It is virtually free from any foreign influence; the extensive Japanese literature does not appear in the bibliography, and though a very few of the American papers are listed, they seem to be unfamiliar—the names of Haskell and McMillan, for example, are given as Hassell and Millan. This may well be due to the German prohibition of the use of alternating current for fishing, but it results in a serious lacuna, and denies the book the title of

a comprehensive treatise. In general, the author seems to be most confident when dealing with laboratory conditions; he does not follow up his dissertation on water conductivity by explaining its correlation with the power demand and the extent of the effective fishing field or the relationship between anode and cathode sizes, which are all fundamental in practice.

To sum up, Dr. Denzer has written a useful book, which will save those interested a great deal of time spent in the study of useless papers, and although it cannot be regarded as complete, it is a distinct achievement to have compiled such an account, while its shortcomings are such that they may be excused in a pioneer. W. G. HARTLEY

NEANDERTHAL MAN

Les Néanderthaliens

Anatomie, Physiologie, Comparaisons. Par Étienne Patte. Pp. 560. (Paris: Masson et Cie, 1955.) 5000 francs.

IN the summer of last year an interesting conference was held at Düsseldorf to celebrate the centenary of the discovery of the remains of Neanderthal man in a near-by cave. Although the conference received little attention in the scientific press, it was a worthy occasion in the history of palæoanthropology. For the discovery which it commemorated was the first which led to the recognition that physical types of humanity existed in the past which were very different from those which live in modern days. At the time of the original discovery in 1856, the Neanderthal skull aroused controversies which to-day seem to have been unnecessarily acrimonious, but then such controversies always do seem (and, because of the hidden emotions engendered, perhaps always will be) the fate of discoveries of early man or his progenitors. Since Neanderthal man came to light near Düsseldorf, many other remains of the same physical type have been found elsewhere, and together (in spite of local variations) they show a rather remarkable uniformity in their basic characters. Perhaps more has been written and speculated about Neanderthal man than any other Palæolithic type, and there is no reason to suppose that the last word on his origin and fate has yet been pronounced.

The publication of Dr. E. Patte's book in the centenary year of the Düsseldorf discovery is opportune, but it is disappointing that it adds nothing new, either in analysis of structural features or in their interpretation in terms of function and evolutionary relationships. It is, in fact, a compilation, and a far from complete one at that. But the author shows a welcome sense of proportion when he comes to deal with certain speculations which have in some textbooks gradually transformed themselves into statements of fact. He rightly discredits the rash inferences which from time to time have been made from a study of endocranial casts, and he finds no reason to accept the suggestion that Neanderthal man walked with a peculiar gait which is so often depicted in illustrations. Here he directs attention to the rather remarkable, but not uncommon, fallacy of comparing fossil skeletal remains only with the skeletal features of the European, with the underlying assumption that the latter can be accepted as a representative sample of modern man as a whole. But, as Dr. Patte remarks in reference to the subject of his monograph, "Il n'avait pas une démarche de Parisien, mais il n'y a pas que des Parisiens sur terre". It is curious that in his list of references the author does not include the important work of G. M. Morant or Clark Howell, for this (together with more recent studies, such as those of Fusté) has provided some of the most suggestive evidence for the theory that Neanderthal man, at any rate in the later stages of his evolutionary development, was a distinct and somewhat aberrant ramification of the genus *Homo*. Indeed, it is commonly accepted that he represents a separate species, *Homo neanderthalensis*. Whether this specific distinction is really warranted will probably only be determined with the accumulation of still more skeletal remains, but at least it gives expression to what even now seems reasonably certain, that the extreme type of Neanderthal man of later Palæolithic date was a divergent type which became extinct and had no ancestral relationship to *Homo sapiens*. W. E. LE GROS CLARK

TECHNOLOGY OF THIN FILMS

Vacuum Deposition of Thin Films

By L. Holland. Pp. xix+542+25 plates. (London: Chapman and Hall, Ltd., 1956.) 70*s*. net.

IN his preface, the author remarks that in this book he has attempted to fill the deficiency existing with regard to a survey of developments in the subject since 1946. After perusal, the reader will surely agree with Prof. S. Tolansky, who writes in the foreword that "As far as I know there is no other text which approaches this subject in so useful a technological manner. There are many papers, many articles, and much tradition. Here we have for the first time an admirable summary of all of this accumulated experience brought together by an experimenter only too familiar with the many pitfalls".

The author has a wealth of experience in the field of vacuum technique, a fact which is very evident from many personal comments he has interspersed on various topics throughout the text. The reader is assumed to have a basic grounding in high-vacuum procedure. As a consequence, this well-established branch of physics is discussed only when pertinent to evaporation and sputtering equipment.

The presentation of the large amount of material is conveniently classified under three main headings: evaporation *in vacuo*, cathodic sputtering, and the preparation of oxide films. A glance through the chapter titles shows how comprehensive is the treatment. The first five chapters deal with evaporation equipment, the degassing of plastic materials *in vacuo*, pre-evaporation cleaning, and the emission characteristics of various vapour sources and film thickness distribution. Evaporation techniques for alloy deposition are mentioned, followed by an interesting account of the growth and structure of vacuum-deposited films.

The ever-growing importance of thin films for electrical and optical applications makes the six chapters devoted to them especially welcome. Detailed descriptions are included of film thickness monitoring techniques for multilayer interference films and the control of the transmission wave-length

of Fabry–Perot interference filters. In connexion with aluminium, the physical conditions during evaporation are considered with respect to the form of the deposited film. Evaporated coatings on plastic materials and the deposition on lacquered components also receive comment, along with the highly important shadow-casting and surface-replication procedures.

The section on cathodic sputtering is concisely written. The really salient features have been competently selected from the formidable amount of literature already existing on this phenomenon. Here again there is much of practical importance, though tempered with some theory.

The final part is very appropriate in view of the recent developments in optics involving the replacement of light-absorbing semi-transparent metal films with thin films of metal oxides, and the innovation of semi-conducting metal oxide films with high transparency as heating elements on glass. Also included are the preparation and properties of a variety of oxide films.

An extremely useful appendix lists the deposition characteristics and refractive indices of a range of inorganic compounds relevant to thin film formation by evaporation or sputtering schedules. The text is liberally provided with diagrams and references and contains a separate author- and subject-index. This is especially valuable in a work which will doubtless find its major value as a source of reference for many years to come. Twenty-four pages of plates complete the book. They are beautifully produced and serve as an admirable conclusion. A. H. Jarrett

THE HUMAN LYMPHATIC SYSTEM

Lymphatics, Lymph and Lymphoid Tissue

By Prof. Joseph Mendel Yoffey and Dr. Frederick Colin Courtice. Second edition. Pp. vii+510. (London: Edward Arnold (Publishers), Ltd., 1956.) 60*s*. net.

THIS book gives a critical review of the history and development of our knowledge concerning lymphatics, lymph and lymphoid tissue. The advances made in this field since Ludwig and his pupils first collected lymph a little less than a century ago is truly remarkable.

The early chapters give a full account of the arrangement and organization of the lymphatic system. The most important chapters are those dealing with the formation of lymph, lymph flow and lymph pressure. The controversy about the precise relationship between lymph and the interstitial fluid from which it arises is discussed in some detail. The authors give their own views on these problems and state that the main purpose of the lymphatics is to return to the blood stream the large protein molecules which pass from the blood capillaries into the tissue spaces. A comprehensive survey of the architecture of the capillary bed, the exchange of proteins through the capillary membrane and capillary pressure is given, and the differences between the blood capillary membrane and the membrane of the lymphatics are discussed. The authors conclude that, "The difference between the two membranes is that while one in offering resistance to the large protein molecules is affected by their osmotic force, the other in readily allowing the passage of such molecules is only affected by the gradient of hydrostatic pressure".

The final chapter gives some details of such disorders of function of the lymphatic system as circulating œdema, hunger œdema, reaction to injury, lymphatic obstruction and lymphatics in the spread of infection. The book is not only a review of the work that has been done by others but also gives the conclusions reached by the authors as the result of their own investigations into the many aspects of the subject of lymphatics. An extensive and valuable bibliography is given at the end of each chapter.

The obvious conclusion to be drawn from reading the book is that it is an absolute necessity to all who are interested in the investigation of the lymphatic system. W. J. Hamilton

ZOOLOGY EXPANDS

The Zoological Record, Vol. 90

Being the Records of Zoological Literature relating chiefly to the year 1953. Edited by G. Burder Stratton. Pp. 1750. (London: Zoological Society of London, 1956.) 120*s*.

THE present volume, relating mainly to zoological literature published in 1953, shows an increase of three hundred pages on the previous year. Part of this increase is the result of including the sections on Vermes and Trilobita, which were omitted last year; but excluding this the over-all figures indicate a rise of approximately 10 per cent in the number of zoological publications between 1952 and 1953. There is good evidence in support of the view that this growth of interest in zoology is continuing, for the sectional parts dealing with the literature for 1954 are larger than those for 1953, though the increment is not as great as was that of the previous year.

It should be emphasized that the sections of the "Zoological Record" are published separately as soon as they are ready for the press, in many cases more than a year before the bound volume is available. For example, the literature for 1954 is already available in sectional parts for most groups of the animal kingdom. Some groups present greater difficulties of recording than others, and the compilers of the various sections receive such slight remuneration that their work must be regarded as largely voluntary, so that the results are all the more commendable.

The difficulties of compiling a record of this kind with its lists of titles in all languages, apart from the classification of the information, can scarcely be over-estimated, and the editor and recorders of sections are to be congratulated on the issue of the majority of the sectional parts within two to three years of the publications to which they refer.

The sections give some indication of the activities in the various groups of the animal kingdom and, as usual, Insecta, with 4,024 titles, is by far the largest and comprises nearly one-third of the whole volume. Among the other sections, Aves still remains the most popular group, especially among the amateur zoologists, followed in descending order by Mammalia, Vermes, Protozoa, Mollusca, Pisces, Arachnida, Crustacea, Amphibia, Reptilia, Comprehensive Zoology, Echinoderma, Coelenterata, Brachiopoda, Trilobita (for 1952), Bryozoa, Protochordata and Porifera. Finally, there is a list of the new generic

and subgeneric names recorded in the volume, comprising the rather surprisingly high number of 1,602 new names. Whereas Insecta again heads the list with 836, more than half the total, here the position of Aves is reversed, as it is near the bottom of the list with only seven new names. The last new generic name is the enigmatical word *Zyx*, which seems bound to remain at the bottom of any alphabetical list.

It is rather unfortunate that the literature relating to Vermes for 1952 and to Trilobita for 1953 is not yet available, but it is hoped to publish these sections in a later volume. However, this is only a minor defect, and zoologists throughout the world owe a great debt to all those who have helped to compile this invaluable publication. EDWARD HINDLE

PLASTIC METHODS OF STRUCTURAL ANALYSIS

The Plastic Methods of Structural Analysis

By Prof. B. G. Neal. Pp. xi+353. (London: Chapman and Hall, Ltd., 1956.) 45*s*. net.

PROF. B. G. NEAL'S name is well known to those who have followed the development of the 'plastic method' of design and analysis. He has been one of the famous Cambridge team, and a book from his pen on this subject is welcome. The text is pleasant and readable in lay-out—an important virtue—and the author resists the temptation to which so many writers on structures fall a victim: that of going back to the beginning, and laboriously taking the reader, once again, through the elementary principles. Prof. Neal plunges straight into his subject, and writes in a style which is crisp and to the point. He avoids the disease of the single-sentence paragraph which afflicts much writing on technology to-day.

The book, although eminently readable and particularly suitable for the library of the senior student of civil engineering, is nevertheless a serious and critical survey of this approach to the analysis and design of statically indeterminate structures. The plastic method is certain, in the end, to displace elastic analysis; but, judging by the fate of some new ideas in engineering, the period of gestation may well be long. It is particularly valuable, therefore, to find, in the first four chapters, a succinct survey of basic theorems and general methods of plastic design. The professional engineer, as well as the undergraduate, can well understand the procedures described—so much simpler than the complex analyses for elastic frames of high redundancy.

The final four chapters deal with deflexion, minimum-weight design and repeated loading, and with the factors which affect the value of the fully plastic moment. The student of the subject can well expect, from these chapters, to be led to understand the latest developments. The difficult problems presented by multi-story, multi-bay frames could well have been elaborated, and the excellent index does not contain the word 'joint'. Yet the design of the joints in a redundant structure is of vital significance if the structure is to behave as postulated and not to show premature collapse by reason of shear failure of the joints themselves.

Two of the attractive features of the book occur at the end of each chapter, where the comprehensive lists of references will delight the serious student of the subject. The numerous numerical exercises will, similarly, attract the student working for examinations. The contents of the book represent the distilled experience of one of the engineers who have developed this British method of analysis and design, and the matter is the stuff of the future. It cannot be neglected by the young engineer, who is fortunate in having at his disposal such a clear and readable exposition. W. F. CASSIE

PROGRESS IN CHEMICAL ENGINEERING

Advances in Chemical Engineering

Edited by Thomas B. Drew and John W. Hoopes, Jr. Vol. 1. Pp. x+448. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 10 dollars; 80*s*.

THIS is the first of a series of volumes giving up-to-date critical summaries of work in fields of chemical engineering where advances have been rapid in the past few years. Although some of the topics are of wide interest, others will appeal only to small groups and could probably have been better covered by a series of monographs. The individual contributors are all experts in their particular fields, but in some cases do not show the familiarity one would expect with work carried out in Great Britain and elsewhere in Europe.

The first chapter, on the boiling of liquids, begins with a comprehensive account of the phenomena associated with boiling on a submerged surface, and the differences between nucleate, transitional and film boiling are clearly illustrated by a series of photographs. Theoretical and empirical relationships for heat transfer under nucleate conditions are discussed and a detailed theoretical treatment of the nucleation process is given. Many of the expressions are, however, difficult to apply because a number of the factors which determine the nature of the surface defy quantitative definition. The chapter would have been strengthened by a discussion of boiling in long tube evaporators, and of heat transfer at very low temperatures to materials such as liquid air.

The classification and a general summary of the properties of non-Newtonian fluids form a valuable introduction to the second chapter, which then continues with an account of the methods of calculating the pressure drop arising from the flow of a suspension in a pipe. Reference is made to the phenomenon noted by a number of workers—that the pressure drop for the flow of a suspension is sometimes less than that for the flow of the liquid alone. Possible explanations are given, first in terms of slip at the walls of the tube, and secondly by considering the difference in the structure of turbulence in a homogeneous fluid and a suspension. Among other features referred to are the problems of mixing and heat transfer to suspensions, and the chapter concludes with a description of some of the methods of measuring physical properties.

The theory of diffusion is treated in the following chapter at a level which will be beyond most practising chemical engineers. Relations are given for mass transfer in flowing systems for both binary and

multicomponent mixtures of gases and liquids. A number of useful solutions for the diffusion equations for steady and unsteady states are given, and attention is paid to systems in which Fick's Law is not applicable, and to mass transfer accompanied by chemical reaction.

The chapter on turbulence will be of considerable interest to those concerned with heat and mass transfer in turbulent systems. It starts with a summary of the theory of turbulence and then deals with a wide range of applications. It is followed by a chapter on mechanically aided liquid extraction which refers to the many recent developments in this field, including the use of agitated vessels, packed columns, pulsed columns and centrifugal extractors.

The final two chapters are likely to be of much less general interest to chemical engineers. The first deals with the the use of automatic computers in the control and planning of manufacturing operations, and fields well outside what is generally understood as chemical engineering are entered. The volume concludes with a discussion of the use of ionizing radiations for the initiation of chemical reactions and for the sterilization of foodstuffs.

J. F. Richardson

MECHANICAL VIBRATIONS

Mechanical Vibrations

By Prof. J. P. Den Hartog. Fourth edition. Pp. xii+436. (London: McGraw-Hill Publishing Company, Ltd., 1956.) 67*s.* 6*d.*

Practical Solution of Torsional Vibration Problems

With Examples from Marine, Electrical, Aeronautical, and Automobile Engineering Practice. By Dr. W. Ker Wilson. Vol. 1: Frequency Calculations. Third edition, revised. Pp. xxxii+704. (London: Chapman and Hall, Ltd., 1956.) 105*s.* net.

Rayleigh's Principle and Its Applications to Engineering

The Theory and Practice of the Energy Method for the Approximate Determination of Critical Loads and Speeds. By Dr. G. Temple and Dr. W. G. Bickley. Pp. vi+154. (New York: Dover Publications, Inc., 1956.) 1.50 dollars.

MECHANICAL engineers who are interested in vibration will be quite familiar with Prof. J. P. Den Hartog's book. It has been required reading for years, and is one of the few really first-class engineering text-books that are a pleasure to read. Its author obviously enjoys writing books and clearly means his readers to enjoy reading them.

The layout of "Mechanical Vibrations" remains the same in this, its fourth edition. That is to say, it contains eight chapters which deal with kinematics of vibration, systems with one degree of freedom, systems with two degrees of freedom, many degrees of freedom, multicylinder engines, rotating machinery, self-excited vibration and, finally, systems with variable or non-linear characteristics. These subjects are covered lucidly and thoroughly and the book's essential freedom from mathematical sophistication is preserved.

Although changes have been made in every chapter, the most obvious differences appear in the last two. These now contain new material, with interesting discussions of problems that have come to light in the past ten years. These treatments of self-excited vibration and of systems with non-linear characteristics are very fine pieces of technical writing indeed. Apart from the new material in the text, more than a hundred extra examples (with answers) have been included. This does not mean that the book has merely been expanded; it has had a proper overhaul and has, in fact, been shortened a little. This book is not primarily concerned with the mathematical theory of vibration. It is written for engineers who have practical problems to solve, and to them it can be recommended without reservation. This is engineering literature at its best.

Dr. W. Ker Wilson's book was first published in 1935 and a second edition appeared in two volumes in 1940. The third (revised) edition is again in two volumes, of which the first is here under review. The book has been completely rewritten and is now arranged so that each volume is self-contained. As its title implies, this book deals with a particular type of vibration, and does so in a very down-to-earth fashion. The author has a gift for clear explanation and goes into great detail, so that, for those who have to solve torsional vibration problems, this is an extremely useful book. While it is undoubtedly important as a work of reference, however, it would scarcely serve as a text-book. For one thing, it is too limited in its scope and, for another, its price is too great.

The chapters in the new first volume are devoted to the following topics: simple systems; frequency tabulations; multi-mass systems; simple geared systems; more complicated geared systems; coupling effects in geared systems; effective inertia method—concentrated mass systems; effective inertia method—distributed inertia systems; coupled torsional and flexural vibration in engine systems; equivalent masses; equivalent shafts; official requirements relating to vibration. Those who are familiar with the book will realize that the layout differs quite radically from that of the previous edition. Clearly, a great deal of thought and labour has been lavished on this rearrangement and the great value of the book has certainly been enhanced by it.

Those who are interested in the theory of vibration or in the subject of elastic stability will be glad of the renewed availability of the book by Drs. G. Temple and W. G. Bickley. For it, too, is well known. "Rayleigh's Principle" was originally published in 1933 by the Oxford University Press, but has been unobtainable for some years. It has now been issued by Dover Publications, Inc., as one of its series of inexpensive, but distinctly superior, 'paperbacks'. Although this book is mathematically more demanding than the two mentioned above, the reference in its title to engineering applications is by no means out of place. The authors' purpose is to present a fairly complete account of the principle and of the related theorems of Dunkerley and of Southwell. Ritz's method is dealt with in an appendix.

The Dover Company has done great service to scientists since the Second World War by making otherwise unobtainable books available at competitive prices. At least so far as theoretical mechanics is concerned, the books that have been re-issued by this Company have all been extremely well chosen and that by Temple and Bickley is no exception.

R. E. D. Bishop

The Modern Universe

By Dr. Raymond A. Lyttleton. Pp. 207+16 plates. (London: Hodder and Stoughton, Ltd., 1956.) 16*s*. net.

THIS survey of modern astronomy for 'ordinary readers' is an expanded version of the very successful talks that Dr. R. A. Lyttleton gave during 1955 in the Television Service of the B.B.C. Lyttleton deserves great credit for discharging an obligation laid upon professional scientists to give some account of their stewardship to such readers. His colleagues will admire his adroitness in conveying an astonishing amount of information with such lucidity and conciseness while forgoing all technicalities. They will also, almost certainly, commend his choice of topics. For his object is to describe recent progress and current problems, without forgetting how much of what is traditional knowledge to professionals is new to each fresh generation of readers. So he proceeds outwards from the Earth to the confines of the expanding universe with a wise adjustment of diminishing detail. He thus shows the variety and difficulty of problems on our astronomical doorstep before sketching some of the more general problems presented by the larger and remoter regions of the universe. Incidentally, one of our local astronomical problems to which Lyttleton gives particular attention may soon become topical. A comet now approaching the Sun is expected to give the best opportunity for many years for studying the nature of such objects; it will be of much interest to see if behaviour like that shown (p. 108) in sketches of Halley's comet is confirmed with the use of modern telescopes.

The book is splendidly illustrated by astronomical photographs from the great observatories. As the reviewer has already found, it can be enthusiastically recommended to inquirers who ask quite literally for an introduction to 'the modern universe'.

W. H. McCrea

Whitehead's Philosophical Development

A Critical History of the Background of Process and Reality. By Nathaniel Lawrence. Pp. xxii+370. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1956.) 37*s*. 6*d*.

THE urge to read books about books rather than to seek out the original sources is always with us. It is perhaps at its strongest when the fountainhead is not hard to find, but is hard to interpret. So it has always been with the philosophical writings of Alfred North Whitehead, from the appearance of his first major work in this field (1919) until well into the late nineteen-thirties and perhaps beyond. As Prof. N. Lawrence remarks, Whitehead's epistemological development was not 'linear'; it might almost be described as following a kind of logarithmic spiral, spotlighting the origin time and again at different orientations and distances.

This, together with Whitehead's individualistic type of vocabulary, has often been the near-despair of students, as indeed it was of the present reviewer some thirty years ago. Prof. Lawrence not only traces the path through such entities as 'event-particles', 'puncta' and 'rects', but also brings the reader abreast of something like a clear image of the spatio-temporal relations as they gradually unfold in the master's work.

There are passages thus clarified which seem to be relevant to the task of the present-day 'directional' biologist, in his rejection of too mechanical a view of the mind–body problem. Historically, and on the grand scale, Whitehead's thought comes very close to that of Anaxagoras of Clozonomae in claiming for his Creator (or νοῦς) not only supremacy as master-builder, but also as artist. F. I. G. Rawlins

The Human Species

A Biology of Man. By Anthony Barnett. (Pelican Book No. A341.) Pp. xiii+351+32 plates. (Harmondsworth, Mddx.: Penguin Books, Ltd., 1957.) 5*s*.

IN view of its many publications over a number of years on specialized biological subjects, it is surprising that no Penguin Book has previously appeared addressed to the general reader beginning the study of the biology of man. The omission has now been remedied in a book which includes sections on heredity and reproduction, evidence and theories of evolution, the races of man, eugenics, differences between men and women, the origins of man, his health and nutrition and his demography. The author has benefited by help given by a number of distinguished biologists to produce a book of wide range which still, fortunately, bears the design and imprint of one author. Errors are very few, although some sections receive superficial treatment while others are treated cavalierly. The scant reference to endocrine organs is surprising, while a chapter on health and disease can scarcely claim to be complete without some reference to cancer. Thirty-two plates, many diagrams, an extensive bibliography and a well-devised index add to the value of what should prove to be another Penguin success.

T. H. Hawkins

Diseases of Garden Plants

By A. Beaumont. Pp. 152+16 plates. (London: W. H. and L. Collingridge, Ltd.; New York: Transatlantic Arts, Inc., 1956.) 25*s*. net.

THERE are probably few people better qualified to write this type of book than Mr. A. Beaumont, who has, for some thirty years, been advising growers on plant diseases, first in South-West England and more recently in Lancashire and Yorkshire. A book such as this has been needed for some time because, as the author points out, no book dealing with diseases of ornamental plants has been published in Britain since 1906. Mr. Beaumont's book deals with these diseases and with diseases of other garden plants. It is based on a series of articles which were published in the *Gardeners' Chronicle* for the practical man whose knowledge of botany was expected to be slight. After two introductory and general chapters on the symptoms and control of plant diseases there follows a series of chapters on diseases of different groups of garden plants. The symptoms of each disease are described briefly and clearly and methods of controlling the disease are given when this is appropriate. A most attractive feature of the book are the sixty-three photographic illustrations of specific diseases; these with very few exceptions are excellent.

There are a few minor points which might be corrected in a further edition, but they in no way detract from the value of the book, which is very well produced, is reasonably priced and will be most useful to the practical man and to students of horticulture and allied subjects.

WHAT IS TEA?

By W. WIGHT and P. K. BARUA

Scientific Department, Indian Tea Association, Tocklai Experimental Station, Cinnamara

TEA is a very old and popular beverage. More than one-third of the Western world's tea is made in India, where the Government has taken steps to define this important export. The general definition[1] states that tea is made from "plants of the *Camellia* genus and *Thea* species". Although this is not a proper botanical definition, it is adapted to the botanical uncertainties of the situation: it could be presumed to mean *Camellia thea* Dyer, an invalid name synonymous with *Camellia sinensis* (L.) O. Kuntze; but it could also mean the several species in the *Thea* section of the genus *Camellia*. Both possibilities are of great interest.

The question arises as to whether all the plants from which a product is manufactured and generally traded and accepted as 'tea' are identifiable with *C. sinensis* (L.) O. Kuntze. Among taxonomists the tea plant is commonly said to be *C. sinensis*, with the implication that ordinary tea (that is, 'tea' without any qualifying adjective as 'Paraguay', etc.) is made solely from that species. Such an understanding is a consequence of the classical source of tea in a plant defined as *C. sinensis*; but it does not follow that all which is now accepted as tea can properly be identified with legitimate *C. sinensis*. By 'accepted' we mean accepted without question by professional tea tasters.

If we reject the foregoing question, then we have to decide whether acceptable tea can be made from each of the plant species in the *Thea* section of the genus *Camellia*.

Several authors[2–4] have recognized various infraspecific categories of *C. sinensis*; but the only ones that have met with general acceptance are described by Kitamura[5] as *C. sinensis* var. *sinensis* (L.) and *C. sinensis* var. *assamica* (Masters). Another species in the *Thea* section of the genus *Camellia* is *C. taliensis* W. W. Sm. A species allied to the latter, but quite distinct from *C. sinensis*, has been described by Barua[6] as *C. irrawadiensis*. This was originally discovered in association with village cultivated tea, and has become known at Tocklai as 'Wilson's *Camellia*', from the name of the collector. Either Wilson's *Camellia* or *C. taliensis* could be mistaken for *C. sinensis* by an uncritical observer.

It is likely that *C. taliensis* could be used for the manufacture of acceptable tea; but we have not had the opportunity of experimenting with this species. On the other hand, by applying standard methods of manufacture to Wilson's *Camellia*, we made a product superficially indistinguishable from tea: this became one among many samples of a more usual nature sent to an experienced English taster under the sole designation of a set of random numbers. The dry 'tea' from Wilson's *Camellia* was accepted at first sight, but when infused with boiling water, then the liquor was at once rejected; and this led to the comment that the product was spurious and could have value only as an adulterant of the dry substance sold in the market.

Experimental F_1 hybrids of Wilson's *Camellia* with *C. sinensis* var. *assamica* look like the latter. A characteristic red pigment of young leaves of Wilson's *Camellia* disappears in many of the progeny and is visible as a seasonal phase in others. From the shoots of the hybrids it is possible to make a product that is not of the best quality, but which the taster accepts without question as tea.

Such hybrids are not tea plants in the commonly understood sense of taxonomists. If they can be a useful source of acceptable tea, then plant breeders could ignore taxonomic considerations, but might feel constrained by the restrictions inherent in the ambiguous phrase "*Camellia* genus and *Thea* species".

Leaves of Wilson's *Camellia* differ from those of *C. sinensis* by the presence of numerous very distinct pellucid dots. The dots are less in the hybrid between the two taxa, and can be further reduced when the hybrid is back-crossed with *C. sinensis* (var. *assamica*). It is concluded that the presence of punctate individuals among the offspring of presumptive *C. sinensis* plants is an indication of hybridization in earlier generations with *C. irrawadiensis* or with some other *Camellia* possessing similar punctations.

Table 1 gives the incidence of pellucid dots in material examined by us in 1956; so far as we are aware, these are the first data to follow Masters's[7] original observations on the subject in 1844.

In Wilson's *Camellia* the dots are more or less evenly dispersed over the lamina; they can be seen distinctly with a hand lens. Those of F_1 hybrids may be seen better in one part of the leaf than another, or may be seen in only one part of the leaf, or may not be seen at all with a hand lens. In Wilson's *Camellia* each dot indicates a sclereid that is in close contact with both upper and lower epidermis; in *C. sinensis* this is a most unusual condition, and sclereids may be completely absent from the lamina. Hybrids possess sclereid intergrades that give more or less indistinct dots. It was considered sufficient for our purpose to scrutinize the whole of a fresh leaf at a magnification of twenty diameters with powerful sub-stage illumination, and to assign the leaf subjectively to one of five grades of

Table 1. Pellucid Punctations in Leaves of *Camellia* Hybrids

Nature and source of material (class)	Punctation grades					
	Nil	1	2	3	4	Max.
C. sinensis var. *assamica* from Lushai Hills	73	2	3	2	0	0
C. sinensis var. *assamica* from Naga Hills	60	0	0	0	0	0
Southern race from Indo-China	60	0	0	0	0	0
C. sinensis var. *sinensis* from China	62	7	1	0	0	0
C. irrawadiensis from north Burma	0	0	0	0	0	10
Var. *assamica* plant '*A*'	10	0	0	0	0	0
'*A*' × *C. irrawadiensis*	9	3	3	3	12	0
Var. *assamica* plant '*B*'	9	1	0	0	0	0
'*B*' × *C. irrawadiensis*	0	1	4	8	17	0
Hybrid plant	0	0	3	2	5	0
Var. *assamica* plant '*C*'	9	1	0	0	0	0
Backcross: Hybrid plant × '*C*'	24	5	1	0	0	0
Cultivated plants	65	43	16	12	14	0

dot incidence (punctation); a sixth grade, with larger dots exceeding all others in number, was required solely for Wilson's *Camellia*. Normally, ten leaves were taken from one plant, the number of leaves being recorded in Table 1; thus the class totals for populations are ten times the number of plants examined, unless single plants are specified.

In Grade 1 the dots are small and the whole lamina had to be examined before a few dots could be found.

The var. *sinensis* material is from seed collected from a completely isolated population of bushes believed to have been established by the Government from imported seed about 1844 and considered by us to be typical; the variety (in this form) is no longer cultivated in Assam, though its genes have undoubtedly been introduced with varying frequency into predominantly var. *assamica* populations now in cultivation. In some of these populations some of the plants approach the typical var. *sinensis*; such 'rogues' are commonly regarded as 'China' plants.

To represent wild var. *assamica* we have used trees raised from seed collected in the Lushai Hills (23·44° N., 93·30° E.) and trees that are the offspring of an orchard established from seed believed to have been collected in the Naga Hills in the region 26·45° N., 94·40° E.

The southern race is the offspring of plants raised from seed collected in Indo-China. It seems taxonomically closer to var. *assamica* than to var. *sinensis*, but differs from the former in a seasonal development of blood-red pigment in the leaves.

Camellia irrawadiensis was raised from seed collected in north Burma; only one plant exists in Tocklai. Pollen from this was used to breed hybrid progenies from which plants for the present investigation were taken at random. A plant from a much older set of similar hybrids had been crossed, not with a recurring parent, but with one taxonomically comparable with the original var. *assamica* parent; this mating produced the F_1 progeny designated 'backcross' in Table 1.

Extensive replanting of Assam estates in recent years has given prominence to populations many of which are not recognizably different from wild var. *assamica*[8]. A large part of the replanted area was occupied originally by the very different cultivated plants instanced in Table 1. Such plants are needed to make the rare and expensive teas of Darjeeling in north Bengal; they still constitute a large part of individual estates in Assam, where they probably account for 5–10 per cent of the total area of tea plantation. They are sometimes known as 'China' and sometimes as 'China Hybrid', the latter term implying a China plant that is larger than 'real' China because of a China × Assam ancestry. This supposed origin does not agree with our ideas of taxonomy (Table 2), and the available evidence leads us to interpret this large and important class of cultivated plants as species hybrids. Can they, in all circumstances, be regarded as legal tea plants?

Table 2. PELLUCID PUNCTATIONS RESULTING FROM A CROSS BETWEEN THE ASSAM VARIETY AND THE CHINA VARIETY OF *C. sinensis*.

Nature of material (class)	Punctation grades					
	Nil	1	2	3	4	Max.
Var. *assamica* plant '*D*'	10	0	0	0	0	0
Var. *sinensis* plant '*E*'	8	2	0	0	0	0
Three plants from progeny *D* × *E*, ten leaves from each plant	30	0	0	0	0	0
Further 20 plants from the same progeny, one leaf from each	18	2	0	0	0	0

As soon as taxonomic research on the genus as a whole can provide a background of knowledge appropriate to investigation of the cultivated crop, then this may be found much more complex than appears at the moment. The existing evidence, however, is sufficient to raise the question as to what is meant by the word 'tea' when used in the tea trade and industry? Must this word be restricted to one species; could it include other species; or should we admit that tea is made from *Camellia sinensis* (L.) O. Kuntze and hybrids thereof?

[1] Government of India. The Gazette of India (Extraordinary) 1955, 2(3), 2107: Notification No. S.R.O. 2106, dated September 12, 1955.

[2] Cohen Stuart, C. P., *Z. Pflanzenz.*, **7**, 157 (1920), quoted from Hunter, H., and Leake, H. Martin, "Recent Advances in Agricultural Plant Breeding", 181 (London, 1933).

[3] Humbert, H., and Gagnepain, F., "Supplement à la Flore Générale de L'Indo-Chine. Tome premier", 313 (Muséum National d'Histoire Naturelle, Paris, 1943).

[4] Kingdon-Ward, F., *Nature*, **165**, 297 (1950).

[5] Kitamura, Siro, *Acta Phytotax. and Geobot., Kyoto*, **14**, 56 (1950).

[6] Barua, P. K., *Camellian*, **7**(4), 18 (1956).

[7] Masters, J. W., *J. Agric. and Hort. Soc. of India*, **3**(2), 61 (1844).

[8] Wight, W., *World Crops* **8**(7), 265 (1956).

THE MIDLANDS EARTHQUAKE OF FEBRUARY 11, 1957

By DR. A. T. J. DOLLAR

Department of Geology, Birkbeck College, University of London

THE special interest of this earthquake lies in its indication of further crustal stress-relief in a region of former repeated activity, in the large area of England and Wales which it disturbed, in its relatively high intensity over the epicentral region and in the degree of structural damage and examples of human injury which it caused. Also of interest is the fact that the incidence of the main quake near a relatively quiet period in the middle of the afternoon, and that of the main after-shock at a time when many observers had gone to bed, but were not then asleep, has caused details to be appreciated and reported which otherwise might have passed unnoticed.

In gathering non-instrumental information about the earthquake, once again the efficacy has been established of wide distribution of a short, simple questionnaire, combined with appeals through the Press and by radio broadcasts. The response to these requests has been very satisfactory, both as regards the quality and the number of reports received.

The questionnaire is that introduced by me in June 1939, after testing and discarding two more elaborate questionnaires in the previous four years[1].

It consists of six questions on a stamped postcard which the recipient is invited to complete and return as soon as possible. After giving style, name and address, the recipient is asked to state: (i) whether or not he or she felt the earthquake, and if so (ii) its estimated time of arrival, (iii) its duration and nature, (iv) its chief effects, (v) whether or not any sound was noticed before, during or after the shock, and if so, (vi) the duration and character of this sound. A space for supplementary notes is provided.

This questionnaire has been distributed throughout England and Wales, including the Isle of Man and the Channel Islands, and southern Scotland, with an explanatory letter. Wherever possible, it has been sent to (i) people of known scientific training who are in touch with others of similar training, such as science teachers in schools and universities, workers in observatories and scientific research laboratories, engineers and medical practitioners; (ii) those professionally concerned with timing and recording, such as postal, railway and airport officials; (iii) responsible officers in the police and fire services; (iv) senior officials in relatively quiet places, such as museums, public libraries, hospitals and banks.

The data so collected constitute the main basis of the analysis, but appeals for information through letters to editors of periodicals, and through a short radio broadcast from the London Station of the British Broadcasting Corporation at 9.25 p.m. on February 12, have elicited much additional useful information which is still arriving at the time of writing.

After assigning intensities in accordance with the Davison Scale[2], or the Modified Mercalli Scale[3], and plotting them geographically, isoseismals will be drawn, the disturbed and meizoseismal areas delimited, and conclusions drawn about the probable strike and hade of the originating fault, the likely position of the epicentre and the position and approximate horizontal length of the focus. Also, the boundary of the sound area will be sought, and isacoustic lines drawn, if information of suitable quality and abundance is available.

A preliminary review of data already received through the British Earthquake Inquiry (an organization established by me at Emmanuel College, Cambridge, in 1935; transferred to the University of Glasgow in 1939 and to the University of London in 1950) shows that the main shock was felt most distinctly on February 11 at about 15h. 43m. G.M.T. in a region immediately north-west of Charnwood Forest between Derby, Nottingham and Leicester.

So far, there is no clear indication of any foreshock, but, on the other hand, there is abundant evidence of an after-shock on February 12 at about 23h. 59m. 30s. G.M.T., which was felt not only over a wide area of Derbyshire, Nottinghamshire and Leicestershire, but also as far east as Dereham and Gorleston in East Anglia, and possibly as far south as Crowborough, Sussex. To the west and north its limits are not so clear.

Although the precise boundary of the disturbed area is ill-defined, as yet, available records indicate that it extends northwards to West Hartlepool, eastwards as far as Diss, southwards as far as Southampton, and westwards as far as Aberystwyth. Single reports also suggest the quake was felt in Ambleside, and at Topsham, between Exeter and Exmouth.

The first estimate of the area disturbed, made in terms of data available on February 12, was about 30,000 square miles, but reports which have arrived since then suggest that the shaken area was more than twice that size. It will be noticed that this does not correspond to the area within isoseismal IV (Davison Scale) which was adopted by Dr. C. Davison in comparing the sizes of regions disturbed by British earthquakes[4].

In the epicentral region, which includes Derby, Ilkeston, Nottingham, Melton Mowbray, Leicester, Loughborough, Coalville and Ashby-de-la-Zouch, the damage to chimneys, masonry and brickwork indicates an intensity of VIII (Rossi–Forel or Davison Scale), or VII (Modified Mercalli Scale). However, not enough data have yet been plotted to enable isoseismal VIII to be drawn with accuracy. Nevertheless, a first approximation to this ellipse suggests that the difference in length between its major and minor axes is not likely to be great, and the intersection of the axes is close to Diseworth, Leicestershire, approximately 52° 48′ N., 01° 20′ W., at or near which town the epicentre may prove to be. A more exact determination must await a full plot of all available estimates of intensity.

A first analysis of available records shows that the main quake is reported by the majority of observers as having been felt on or near 15h. 43m. G.M.T., the range of estimated times lying between 15h. 40m. and 15h. 55m. G.M.T. The reported duration of the quake varies between 0·5 sec. and 60 sec., but is most commonly about 5 sec.

In the majority of reports, observers appear to have noted evidence of only one main impulse. Nevertheless, two impulses are suggested by the account of a Loughborough signalman who compares the quake to the effect of "two explosions, separated by 3 seconds", and this is substantiated by the "two bumps" felt by an observer at King's Lynn, by the two distinct parts of a tremor, compared to that from a "far explosion" by an observer at Bedford, by the two shakes, separated by approximately one second, reported by an observer at Aylesbury, by the two distinct tremors noted by a Kidderminster observer and by the shake compared to "two claps of thunder, close together" by a Shrewsbury observer. Whether or not this indicates that the quake originated from two detached foci it is too early to say. That is a possibility, however.

In the epicentral region the main disturbance is compared to one produced by a collision between heavy vehicles, or between a locomotive and buffers, by the passage of a loaded train or lorry, or by the derailment of a group of goods wagons. Others compare it to the result of an explosion, heavy bombing, gunfire, or the fall of a heavy object.

It is in this region that a number of chimneys were thrown down, particularly in Loughborough and Derby. Also a stone cross, about 12 in. high and estimated to weigh 30 lb., was dislodged from the top of the Loudoun Memorial at Ashby-de-la-Zouch, masonry from a chimney fell on the roof of the General Hospital at Loughborough, and a television aerial was thrown from a roof at Sneyd Green, Stoke-on-Trent. Floors were felt to heave and a cinema screen shook, in Nottingham, while plaster was thrown from ceilings in Loughborough and Burton-on-Trent, among other places. A roof shook strongly at Nuneaton. An unlatched door was opened about an inch, and closed again, at Narborough, while a closed door at Salford was opened by the shock. Doors and windows were rattled in Burton-on-Trent, cupboards made to creak in Stoke-on-Trent, while at Derby, a chair, with the observer seated in it, was

shaken, and a table was moved in Retford. A bed was rocked at Church Warsop, crockery was rattled in Kidderminster, a substantial stone building was shaken at Grantham and curtain rails were vibrated in Aylesbury, as a result of the quake.

The sounds associated with this main quake are reported by many observers to have been heard for about five seconds in the epicentral region, but durations of one second to seventy seconds have been mentioned. A first assessment of the evidence suggests that the sound-area extends at least as far as Doncaster (and possibly Preston) on the north, Oakham on the east, Nuneaton on the south and Shrewsbury and Chester on the west, but the boundary of this area cannot be determined until more of the available information has been plotted.

Over a large part of this region there are reports that the sound was noticed at the same time as the shock; but observers in Stoke-on-Trent and Derby heard the sound before the arrival of the shock, an observer in Shrewsbury noticed the sound both before and at the time of the shock, observers in Loughborough and Nuneaton noticed the sound both during and after the passage of the shock, an observer near Mansfield reported that the sound followed the shock, and observers in both Leicester and Preston noticed that the sound preceded, coincided with and followed the shock.

The sound has been compared to that of throbbing marine engines at Leicester, to a wind at Nottingham, to the rumble of a train or a distant explosion at Derby, to that of heavy traffic at Castle Bromwich, to thunder at Stoke-on-Trent and Shrewsbury, to wagons in collision at Nuneaton, to low jet aircraft at Oakham, to a dull subterranean thud at Macclesfield, to heavy gunfire at Worksop and to a distant explosion at Sheffield.

Underground, several thousand miners in the Leicestershire and Derbyshire coalfields were disturbed by the shock, and in some cases came to the surface on that account. In the workings, pit props were shaken, coal dust thrown into the air, and trolleys loaded with coal were rocked slightly on their rails. The accompanying sound was described as a deep rumble, or like that of a depth charge.

The after-shock, which was of less intensity than the main quake, has been reported by relatively few observers. The time commonly mentioned is 23h. 59m. G.M.T.; but the range extends between 23h. 45m. G.M.T. on February 12 and 00h. 2m. G.M.T. on February 13. In available accounts there is nothing to suggest that more than one main impulse was involved in this disturbance.

Among other effects, it caused beds to shake at Chapel-en-le-Frith, in Carlton, near Nottingham, at Dereham and at Uttoxeter, it shook a loose door at Chapel-en-le-Frith and rattled windows at Carlton and Dereham. The duration of the shake is reported to have been about three seconds, with a range of between one second and six seconds. The accompanying sound was compared to a gust of wind in trees at Chapel-en-le-Frith, and to that of an explosion at Radcliffe-on-Trent.

Instances of human injury due to an earthquake originating immediately beneath the British Isles are rare. Thus, about 18h. on April 6, 1580, an apprentice was killed in London by a stone dislodged from the top of Christ Church through an earthquake of intensity VIII (Davison Scale)[5], while at 10h. 35m. on April 30, 1921, a quake of intensity IV (Davison Scale) caused the collapse of a bank of sand and gravel near the golf course at Comrie, Perthshire, thereby nearly burying a passing girl[6]. The rarity of these occurrences, however, lends unusual significance to the fact that the recent earthquakes caused severe head injuries to a four-year old boy due to a falling chimney stack in Markeaton Street, Derby, while at the same time his mother was cut on the ankle by debris from this stack, and a woman in Ilkeston was cut on one leg by a piece of chimney pot dislodged by the same quake.

Known seismic foci in the immediate vicinity of Derby fall into three groups. There is a north-western group, entirely in Derbyshire, an eastern group in south-west Nottingham, and a south-eastern group, with some foci in north-west Leicestershire[7].

In the first group, the foci lying 11 miles west-north-west and 13 miles north-north-west of the centre of Derby, with epicentres 1 mile east of Ashbourne and 3 miles west of Wirksworth, respectively, are particularly interesting as being the joint origins of the twin earthquakes of 1903, 1904 and 1906, the first of which, on March 24 at 13h. 30m., nearly attained intensity VIII (Davison Scale). Here it may be remarked that, as yet, there is no unequivocal evidence to suggest the present quake is a twin.

With these twin foci may be associated the centre or centres from which the tremors of Winster, 17 miles north-north-west of Derby, originated in 1952 and 1954—if, in fact, these disturbances were earthquakes and not mine shakes[8].

The second or eastern group includes foci beneath or near Nottingham which were active in 1180 and 1873, and at or near Beeston which functioned in 1857 and 1865. Charles Davison estimated that the Nottingham quake of April 25, 1180, was of intensity VIII.

It is to the third or south-eastern group that the focus of the recent quake is most likely to belong, as do those known Derbyshire foci which have been active since 1872.

Of previous earthquakes originating immediately south-east of Derby, that which occurred on November 18, 1795, at about 11h. 10m.—"the strongest of all recorded earthquakes in Derbyshire", according to Davison—resembles the most recent one in a number of particulars, including its intensity (VIII, Davison Scale) and the area which it disturbed (about 30,000 square miles). Unfortunately, the exact position of its focus is unknown. Prior to this, Derbyshire earthquakes were recorded in 1084, 1678, 1734, 1738, 1748, and afterwards, in 1872.

The most recent quake in the immediate vicinity of the present one is that of January 10, 1956, at 08h. 11m. 51s. G.M.T., with a possible after-shock from the same locality soon after 10h. G.M.T. on the same day, to which Mr. E. Tillotson assigns an epicentre near 52° 50′ N., 01° 25′ W. (that is, about six miles south-south-east of the centre of Derby) on the basis of instrumental evidence[9]. This determination accords with the available non-instrumental evidence.

In connexion with the date of the present earthquake, it is noteworthy that the monthly variation in the frequency of British earthquakes between 1750 and 1916 shows a minimum in February, as discussed by Davison[10]; but for Scotland, over the period 1916–49, the nearest corresponding minimum falls in April, as discussed by me[11].

The characteristics of this disturbance and its after-shock suggest that they are local British tectonic earthquakes probably arising from motion

across a fault which cuts the Pre-Cambrian basement of the Derby–Loughborough district and possibly has a north-westerly strike. Since present non-instrumental evidence suggests that the epicentre lies at or near Diseworth, but affords no indication of a likely depth for the focus, the main quake, and perhaps its after-shock of February 12, may have resulted from motion across a deep continuation of either the Breedon Fault or the Normanton Hills Fault[12], or possibly a third fault which lies between them, completely hidden beneath Triassic deposits.

The Breedon Fault, which occurs about three miles west of Diseworth, strikes between N. 318° E. and N. 344° E., and is known to cut Millstone Grit, but not the overlapping Triassic sediments. On the other hand, the Normanton Hills Fault, lying some two miles north of Diseworth, appears to strike about N. 292° E. and cuts Lower Lias shales and limestones where it is exposed. This dislocation is believed to continue for a considerable distance to the east. However, it is equally likely that this quake and its after-shock were due to movements across a dislocation in the ancient basement which does not cut the overlying younger rocks at all.

The main quake was recorded on the seismographs at Durham, Cambridge, South Kensington, Kew, Dorking and Dublin, but apparently not in readable form at Aberdeen, Edinburgh or Bidston. From preliminary studies of available seismograms, Mr. E. Tillotson suggests an epicentre at 52° 52′ N., 01° 21′ W., that is, about 7·5 miles north-east of Ashby-de-la-Zouch, and an initial time of 15h. 43m. 00s. at a focus perhaps six to eight miles below the surface.

[1] Dollar, A. T. J., *Trans. Geol. Soc. Glasg.*, **21** (2), 285 (1951).
[2] Davison, C., *Phil. Mag.*, **50**, 51 (1900).
[3] Wood, H. O., and Newmann, F., *Bull. Seismol. Soc. Amer.*, **21**, 277 (1931).
[4] Davison, C., *Geol. Mag.*, **7**, 412 (1910).
[5] Davison, C., "A History of British Earthquakes", 333 (Cambridge, 1924).
[6] Dollar, A. T. J., *Trans Geol. Soc., Glasg.*, **21** (2), 312 (1951).
[7] Davison, C., "A History of British Earthquakes", 331–37 (Cambridge, 1924).
[8] Tillotson, E., *Nature*, **177**, 165 (1956).
[9] Tillotson, E., *idem*.
[10] Davison, C., "A History of British Earthquakes", 390 (Cambridge, 1924).
[11] Dollar, A. T. J., *Trans. Geol. Soc. Glasg.*, **21** (2), 292 (1951).
[12] The Geology of the Country between Derby, Burton-on-Trent, Ashby-de-la-Zouch and Loughborough. Mem. Geol. Surv. U.K., 45, 48 (1905).

OBITUARIES

Dr. J. von Neumann

John von Neumann was a remarkable man. Probably the most important of all his qualities were the accuracy and speed of his thinking, whether in a difficult mathematical argument or on a major policy point affecting the allocation of enormous research resources. Primarily he was a pure mathematician, interested in the theory of groups, matrices and operators, but he had great facility in many branches of mathematics. His book on "Quantenmechanik", published in 1932, was a notable exposition of the mathematical logic of the theory. Another book, "The Theory of Games and Economic Behaviour", written in collaboration with the distinguished economist, Oskar Morgenstern, and first published in 1944, gave von Neumann the opportunity to display his powers in combinatory analysis.

When the scientific strength of the United States was being mobilized in the Second World War, von Neumann soon played a prominent part. He began to work on the motion of compressible fluids caused by explosions. He gave the solution of the point source explosion, obtained independently by G. I. Taylor, and he made important contributions to the theories of detonation and of the motion of the triple point in air blast. After only a few months, this great pure mathematician was discussing and planning experiments with his new colleagues, and his suggestions always commanded attention.

As soon as scientific work began at Los Alamos, von Neumann was brought in as a consultant. For the rest of his life, he paid frequent visits to Los Alamos and few had such a decisive influence as he. At Los Alamos, von Neumann realized from the start the importance of machine calculation, and his interest in electronic digital computers received an impetus which lasted through the post-war years. With several collaborators, he went deeply into the mathematical logic of the computers, and even though the machine built under his guidance at the Institute for Advanced Study at Princeton was surpassed by other machines in the United States, von Neumann continued to be one of the leaders of thought on such machines.

The United States Atomic Energy Commission found him to be one of its most valuable consultants. He served on the General Advisory Committee and he continued to play a leading part among all the consultants in influencing the scientific work of the Commission. Finally, in 1955, he became a commissioner.

His tragic death on February 8 at the early age of fifty-four is a grievous loss to American science. Like Enrico Fermi, he was a victim of cancer. He is deeply mourned by many, and those who knew him will never forget his brilliance, his common sense, his loyalty and his sense of humour.

W. G. Penney

The Marchese Solari

The Marchese Luigi Solari, an early associate and life-long friend of Marconi, died in Rome on February 6 at the age of eighty-three after a long illness.

As an officer of the Italian Navy, the Marchese Solari was associated with Marconi's early demonstrations of wireless telegraphy on board Italian warships in 1897, and the two men became close friends. When the Italian Government put the warship *Carlo Alberto* at Marconi's disposal in 1902 for the furtherance of his investigations into the propagation of wireless waves, the Marchese Solari accompanied Marconi as the officer in charge of the vessel's wireless telegraph station.

Shortly after his retirement from the Navy he became manager of the Italian branch of Marconi's

Wireless Telegraph Company, Ltd.; in 1927 he was appointed managing director and general manager of the Societa Italiana Radio Marittima, the posts which he held until his retirement.

Mr. James Wright

Mr. James Wright, who died suddenly at his Edinburgh home on January 28, was born in Kirkcaldy, Fife, and educated locally. His father, besides being a keen amateur astronomer with an observatory in his garden, was interested in science generally and gave intelligent encouragement to his son's geological interests. As a young man, Wright, with Robert Dunlop of Dunfermline, John Smith of Dalry and J. L. Begg of Glasgow, joined a group of amateur geologists who used to rise in the small hours to follow their hobby before going to work, and the splendid foreshore exposures of carboniferous rocks in Fife led him to study the Crinoidea. He was encouraged by the late Dr. F. A. Bather, and his first paper was published by the Edinburgh Geological Society in 1912. He had in all more than thirty papers to his name, the most considerable being a review of the Scottish carboniferous Crinoidea (*Trans. Roy. Soc. Edin.*, 1939). His monograph of the British Carboniferous Crinoidea, published by the Palæontographical Society with 83 plates, was nearly completed at the time of his death.

With opportunities limited by a full-time business career, Wright made himself a world authority in his field, respected by professional workers in all countries. His collection, which is bequeathed to the Royal Scottish Museum, far exceeds in quality all others of similar scope, not least because of his exquisite skill as a preparator of fossils in intractable matrices. He was honoured by the Geological Societies of London (Wollaston Fund, 1928; Worth Award, 1956) and Edinburgh (Clough Medal, 1945–46) and by the Royal Society of Edinburgh (Neill Prize, 1939). He will be missed not only as the only British worker in his field, but also as a wise, humorous and generous host and friend.

R. V. Melville

NEWS and VIEWS

Technology

The urgent demands of the national economy for technologists in great numbers and of the highest calibre has placed the reform and expansion of scientific and technological education at all levels from school to university among the most pressing and vital issues of domestic policy in Britain to-day. That the educational system has for so long occupied the attention of successive Governments and occasioned the deliberations of numerous committees of inquiry, and the great volume of debate in the Press and other organs of public opinion, testifies both to the gravity of the situation and the fundamental nature of the measures called for. No facile solution to the complex of problems presented by the national shortage of technologists is going to be found, and continual cross-fertilization of ideas between industry and the world of education will be required if an adequate rate of progress is to be maintained. It is very encouraging and timely, therefore, that *Technology*, a new monthly review of training and education for industry published by *The Times* (pp. 40; 1*s.* monthly), should appear at this juncture. The leading article in the first issue states that "one of the chief aims of *The Times*, in publishing *Technology*, is to provide a platform from which industrialists may declare their needs to the public, to Ministers, and to university professors, technical college heads and schoolmasters and mistresses. In this way, *Technology* will seek to make plain what industry wants from the educational system and where it is dissatisfied. But," the leader continues, "science is a sovereign state, and teaching is an art, and the education of the minds and characters of young people must be left to those whose skill it is. *Technology* offers an equal platform to the teacher".

The first issue of *Technology*, which appeared on March 4, includes a number of incisive and authoritative articles by eminent industrialists, technologists and teachers. Sir Frederick Handley Page and Dr. Willis Jackson discuss education and training for careers in the aircraft and electrical engineering industries respectively, and Mr. Hugh A. Warren describes the French system of *centres d'apprentissage*. An article by Prof. P. Sargant Florence examines the question of education for management, and Dr. D. J. Urquhart reviews the problems arising in the provision of libraries for technical colleges. There are articles on the use of computing machines in planning for the petroleum industry by D. A. Glen, and on liquid-metal pumps in the nuclear power industry by Prof. G. H. Rawcliffe. There are items of news and comment, including reviews of the work and organization of six of the designated Colleges of Advanced Technology, of the shortage of women technologists and of current technical developments in America. The first issue contains a fully fledged column of Letters to the Editor, reviews of books, plays, films and television. An admirably informal and lucid style is maintained throughout. Even in these days, when the proliferation of journals offers a severe tax on the time of any reader who endeavours to remain well informed on matters of public policy, the publication of *Technology* will be very widely welcomed as the answer to a genuine need in the present situation. One may look forward to important contributions in the definition of problems and the formulation of solutions from this new review.

Royal Society of Edinburgh: Prize Awards

The Council of the Royal Society of Edinburgh has made the following prize awards: *Gunning Victoria Jubilee Prize* for the period 1952–56 to Dr. H. W. Melville, for his distinguished contributions to reaction kinetics and the physics and chemistry of high polymers; *Makdougall-Brisbane Prize* (1954–56) to Prof. C. M. Yonge, for his paper in the *Proceedings* during the period of award and in recognition of his many valuable contributions to marine zoology; *James Scott Prize* (1957), to Dr. C. D. Broad for a lecture which will be given on November 11, 1957, on "Some Remarks on Change, Continuity, and Discontinuity". The *Bruce Preller Lecture* (1957) is to

be delivered by Dr. Martin Ryle on some aspect of radio astronomy; it will be given on February 3, 1958.

Organic Chemistry in the University of Liverpool: Prof. A. Robertson, F.R.S.

Prof. Robertson's retirement from the Heath Harrison chair of organic chemistry in the University of Liverpool leaves a big gap in the ranks of natural product chemists. A graduate of the University of Aberdeen, he later studied in Glasgow; but it was his period of research with Sir Robert Robinson in Manchester that introduced him to the field of natural colouring matters containing oxygen-heterocyclic systems, where his main interests have lain. During the five years he spent thereafter in the University of London he established himself as a leader in this field and with his election to the Liverpool chair in 1933 he proceeded to develop research on an impressive scale. Among his many contributions, his brilliant studies on rottlerin and dragon's blood resin, on the constituents of *Derris* root and on usnic acid and its relatives are particularly striking; but many other natural products derived both from higher plants and from micro-organisms have yielded to his attack. His achievements were recognized by the award of the Davy Medal of the Royal Society in 1952. A brilliant experimentalist, Robertson's published work is a model for aspiring young natural product chemists to follow. In wishing him well on his retirement to his native Aberdeenshire, organic chemists at large will hope that he will not wholly forsake the subject to which he has so notably contributed.

Dr. G. W. Kenner

Dr. G. W. Kenner, lecturer in chemistry in the University of Cambridge, is to succeed Prof. Robertson at Liverpool. Son of a distinguished organic chemist, Prof. J. Kenner, lately professor of applied chemistry in the Manchester College of Technology, he was educated at Manchester Grammar School and the University of Manchester, where, after a brilliant undergraduate career, he took to the path of organic chemical research under Sir Alexander Todd and transferred to Cambridge to complete his post-graduate training with Sir Alexander Todd in 1944. Since completing his Ph.D. course, Kenner has remained in Cambridge as Fellow of Trinity Hall and University lecturer in chemistry. In association with Sir Alexander Todd, Dr. Kenner has been responsible for many major achievements in the field of nucleotide chemistry, including the total synthesis of the coenzymes flavin-adenine-dinucleotide uridine-diphosphate-glucose and cozymase. His independent researches on the synthesis and degradation of polypeptides has brought him international recognition; they are marked by the unusual combination of high experimental skill and deep theoretical insight which is characteristic of all his scientific work. His loss will be severely felt in Cambridge, but Liverpool gains a professor who will be a worthy successor to Robinson, Heilbron and Robertson, and organic chemical research under his guidance will have a bright and vigorous future.

Astronomy at Harvard: Prof. T. Gold

With the appointment of Prof. T. Gold to a Harvard chair of astronomy, Harvard College Observatory acquires one of the foremost of the younger generation of scientists in Britain. Prof. Gold's work has ranged over many subjects, each of which has been greatly enriched by the clarity and originality of his thought and by the extraordinary fertility of his ideas. His deep and almost instinctive understanding of the fundamentals of physics has enabled him to apply them to numerous branches of astronomy as well as to geophysics and to the theory of hearing. An exceptional ability to distinguish between essential and less important features of detailed observational knowledge has led him to make such outstanding contributions to science as the theory of continual creation in cosmology, the dust theory of lunar *mare*, the sponge theory of the structure of the Earth's mantle, etc. Prof. Gold is a former Fellow of Trinity College and demonstrator in physics in Cambridge. He has been chief assistant at the Royal Greenwich Observatory for the past few years. His departure must be regarded as a severe loss to British science.

Pharmacognosy in the University of Nottingham: Prof. G. E. Trease

The title of professor of pharmacognosy in the University of Nottingham has been conferred on Dr. G. E. Trease, reader in pharmacognosy in the University. Prof. Trease, who was born in Nottingham and educated at the Nottingham High School, joined the staff of University College, Nottingham, in 1925, and has been in the Department of Pharmacy since that date, apart from two years with the Ministry of Economic Warfare during the War. He became head of the School of Pharmacy in 1943, was appointed reader in pharmacognosy in 1945, and in 1949 was given the title of director of pharmaceutical studies. An honorary doctorate was conferred upon him by the University of Strasbourg in 1954.

André Mayer Fellowships of the Food and Agriculture Organization

The awards of the first André Mayer Fellowships of the Food and Agriculture Organization of the United Nations have recently been announced. These research fellowships are aimed at promoting and encouraging scientific research in the fields of activity of the Organization. Recipients of the awards are: K. L. Kinsman of Australia, whose field is the study of statistical methods of evaluating long-term trends in demand; A. G. Wurtz of France, who will study the ecology of freshwater ponds; A. Sumihiko of Japan, who will study forest tree seeds; Bastos de Macedo of Portugal, studying the mechanics of the retention of phosphorus through pure minerals and through clays of soils; and P. M. Lagervall of Sweden, whose subject is population genetics applied to animal breeding. The five Fellows will be able to follow their studies for periods of one to two years at research institutes in any member country of the Organization.

The research fellowships have been named after Prof. André Mayer of France, who died in May 1956 after a long and distinguished scientific career. Mayer was one of the moving spirits in the formation of the Food and Agriculture Organization, and closely associated with its development and its governing bodies. A physiologist by training, Mayer was a professor at and later vice-president of the College of France and member of both the French Academy of Medicine and the Academy of Sciences. He was also a member of the Higher Council on Scientific Research and of the Higher Council on Agriculture.

Sir George Beilby Memorial Award, 1956

THE Administrators of the Sir George Beilby Memorial Fund, representing the Institute of Metals, the Royal Institute of Chemistry and the Society of Chemical Industry, have made an award of one hundred and fifty guineas to Mr. R. W. Kear in recognition of his work on the behaviour of fuel impurities in combustion processes, with special reference to the role of sulphur, chlorine and alkalis in corrosion and deposit formation by flue gases in combustion appliances. Mr. Kear, who joined the British Coal Utilization Research Association in 1946, became head of the Corrosion Section early in 1954 and was a member of the technical and advisory panel of the Boiler Availability Committee. Although his work was primarily concerned with power station boilers, he has also made contributions to the development of the solid-fuel fired gas turbine and to the problem of atmospheric pollution. He has recently left the British Coal Utilization Research Association and joined the Oil Products Development Department of the Shell Petroleum Company, Ltd.

Guided Missiles Range in the Hebrides

REPLYING to a question in the House of Lords on February 27 regarding the guided-missile range in the Hebrides, Lord Mancroft, Parliamentary Secretary to the Ministry of Defence, said that the precise scope of the Guided Weapons Establishment has not been finally determined, but about 3,000 persons might be employed in connexion with its construction. Lord Mancroft assured Lord Elibank that, apart from any necessary security regulations, there would be no interference with the public right of entry into South Uist, Benbecula and North Uist, and that the Service authorities on all the islands would have constant regard to the safeguarding, so far as is possible, of the interests of the crofting communities, the elements of Gælic culture and all the rare bird life on the islands. Pressed further, particularly in regard to archæological finds at West Gerinish in South Uist and at a site in North Uist near the end of the proposed runway at Sollas, Lord Mancroft stated in reply to a comment by the Earl of Haddington that every possible attention would continue to be paid to the needs of archæologists in this area; and in reply to Lord Saltoun he undertook to look carefully once more into the question of a local inquiry in connexion with the proposed range.

Centenary of the Chemical Inspectorate

UNDER the title "Chemical Service in Defence of the Realm", the Ministry of Supply has published an account by W. G. Norris of the work of the Chemical Inspectorate during the past hundred years (pp. 91+12 plates. Kidbrooke, London: Ministry of Supply, Chemical Inspectorate, 1957). Originally formed in 1854 at Woolwich Arsenal as an establishment of the War Department, the Chemical Inspectorate, which has had five changes of name during its century of service, is one of the oldest Government scientific establishments. To-day, it is one of seven specialist inspectorates maintained by the Ministry to help control the quality and serviceability of its vast range of stores, but it has retained its original function as the inspection authority for all military stores and materials the serviceability of which can be assessed primarily by chemical means. To-day this work, besides the maintenance of standards of quality, includes the compiling of Service specifications, and the development of new and improved analytical techniques and apparatus. It also provides a comprehensive analytical service available not only throughout the Ministry of Supply but also to other Government Departments, such as the Board of Trade, the Ministry of Health, the Home Office and the Ministry of Works. Some of its recent analytical work is described in a final chapter, in which special stress is laid on the value of its work on penicillin and on materials for the production of nuclear energy outside the military field.

Higher Education in the United Kingdom

ALTHOUGH the United Kingdom attracts overseas students in thousands, there is no central agency by which applicants can be selected and appropriately placed in colleges or universities, since these institutions are independent academic bodies enjoying the right to set their own entrance standards and make their own choice of students. This presents a difficult problem for the overseas student who is eager to study or be trained in research in Great Britain and yet does not know in what institutions the subject of his choice is pursued, or by what means he can gain entry to them. To help him, the British Council, in conjunction with the Association of Universities of the British Commonwealth, has prepared a book (5*s*. net) giving the names and addresses of the institutions, what they do, what their minimum entry requirements are, and approximately what fees they charge. That should enable the prospective student to decide in advance in which of them he would like, or might be able, to study. Although compiled for the overseas students, the book should prove equally valuable to British students and would be useful to all who have to advise young men who wish to study at institutions of higher education.

The Imperial College Charter Jubilee

THE Imperial College of Science and Technology celebrates this year the Jubilee of its establishment in July 1907 by Royal Charter, which brought about the federation in the new Imperial College of three colleges of earlier origin—the Royal College of Science, the Royal School of Mines and the City and Guilds College. In the forefront of the Charter Jubilee celebrations will be the visit of H.M. Queen Elizabeth the Queen Mother, as Chancellor of the University of London, on May 28, when Her Majesty will open the Roderic Hill building for aeronautics and chemical engineering. This is the first major building project to be completed in the massive expansion programme undertaken by the College in 1953 at the request of the Government. The Marquess of Salisbury, Lord President of the Council, is to be the guest of honour at the Jubilee dinner to be held at the Mansion House on May 27.

Operational Research and Cybernetics

WITH the aim of advancing the latest managerial techniques of control, the United Steel Companies, Ltd., are to establish a new department of operational research and cybernetics. Based in Sheffield, the department will serve all the branches of United Steel with advice on operational research problems, and will provide the personnel to carry out its proposals. Initially, the department will have a staff of about twenty-five research workers, including biologists, physicists, psychologists, engineers, economists, mathematicians and logicians. Mr. Stafford Beer, formerly production controller at Samuel Fox

and Co., Ltd., has been appointed head of the new department under the general direction of Mr. S. R. Howes, a director of United Steel, who, as general manager of Samuel Fox up to June 1956, was responsible for introducing operational research methods at that works, where they have been applied to production control.

Standards of Light

The Light Division of the National Physical Laboratory has recently completed a new comparison of its secondary standard lamps with the internationally agreed primary standard light source. The British secondary standards are special tungsten filament vacuum lamps held by the Light Division. The international standard is a small ceramic tube, or cavity-radiator, immersed in a crucible-full of pure platinum. The metal is first melted and then slowly cooled. During the short period while solidification is taking place, the temperature remains stationary at the freezing point of platinum. At this temperature, at which the observations are made, the inside of the small radiator has, by definition, a luminance of 60 candelas per square centimetre. More than a hundred 'melts and freezes', obtained with the aid of a high-frequency induction furnace, were used for amassing sufficient observations, which were made by precise photoelectric methods. Because of the Second World War, no such comparison had been made since the occasion, some twenty years ago, when the National Physical Laboratory lamps were first calibrated in this way. Nevertheless, the values now found for their intensity agree, to within one half of one per cent, with the previous ones.

The Night Sky, 1957

A booklet entitled "The Night Sky, 1957", containing charts of the sky for each month, has recently been issued by The Times Publishing Company, Ltd. (London, 1957; 3*s*.). Computations were made for the latitude of London, but for most practical purposes it may be used for any part of Great Britain. Very clear directions are given regarding the use of the maps, which show, in addition to the stars, the positions of the planets at 11 p.m. at the beginning of each month. Data concerning the Moon, eclipses, occultations of planets and transit of Mercury are also provided, and this compilation will prove very helpful to everyone who is interested in studying the heavens from month to month.

Emission Spectra in the Smaller Magellanic Cloud

The results obtained on ADH spectrum plates of stellar-like objects in the Small Magellanic Cloud are discussed by E. M. Lindsay in a paper entitled "Emission Objects in the Small Magellanic Cloud showing the N_1, N_2 Nebular Lines" (*Mon. Not. Roy. Astro. Soc.*, **115**, 3; 1955). The paper deals only with those which show the N_1, N_2 nebular emission lines ($\lambda\lambda$ 5007, 4959)—thirty-three altogether—which were divided into two groups. Group i contains thirteen objects associated with nebulosity and are early-type stars exciting the surrounding nebulosity. Taking a modulus of $m-M = 18{\cdot}9$ for the Cloud, the mean photographic magnitude for these objects is $M = -4{\cdot}9 \pm 0{\cdot}6$, and a mean colour index (blue minus red photographic) of $-0{\cdot}47 \pm 0{\cdot}19$. Group ii contains seventeen objects which are not associated with nebulosity, have little or no continuous spectra, and have a mean absolute photographic magnitude of $-3{\cdot}7 \pm 0{\cdot}6$ and mean colour index $+0{\cdot}77 \pm 0{\cdot}29$. It is suggested that these objects are planetary nebulæ. Eleven other objects showing Hα emission and with the same characteristics as the members of Group ii are possible planetaries. The results of the investigation are shown in detail in the paper in seven tables, the last of which gives the distribution of planetary nebulæ with respect to absolute magnitude, and a plate shows the distribution of probable and possible planetary nebulæ in the Small Magellanic Cloud. One important matter is referred to in the paper; although the Armagh and Harvard blue photographic magnitudes are in fair agreement, the colour indices differ radically in four cases, and it is suggested that part of this may represent the difficulty of estimating magnitudes of stars involved in nebulosity. This difficulty should be appreciated by observers who estimate the magnitude of a comet with a strong central condensation, the divergences in the estimate being sometimes considerable. It was found that, when the nebulosity became sufficiently dense to be troublesome, the estimates of the magnitudes of the stars became systematically fainter with increasing density.

The Haughley Experiment

In 1939, the Local Medical and Panel Committee of the County of Cheshire, representing some six hundred general practitioners, issued a "Medical Testament" (*Brit. Med. J.*, i, supp. p. 157; 1939) deploring the fact that knowledge of how to prevent sickness had made so little progress and affirming its belief that the basis of such prevention was essentially nutritional. Since then, medicine has made further advances in the treatment of disease, and agriculture and food technology together ensure an abundance of food at all seasons of the year, but the desired mental and physical health of the community seems further away than ever. There are many possible reasons for this, and one at least is that it is the cumulative effect of the intensified processing to which practically every article of our present-day diet is now subjected. The Soil Association believes (*Brit. Dent. J.*, **102**, 61; 1957; *Lancet*, i, 144; 1957) it is necessary to look still deeper and that it is of vital importance to wean food producers away from their pre-occupation with nitrogen–phosphorus–potassium fertilizers and to teach them to think of the soil and its crops and the animals that live on those crops as one organic whole. Since 1940, the Association has been engaged on a farming experiment at Haughley, Suffolk, putting its ideas to the test (*J. Soil Assoc.*, October 1956). It appreciates the extreme difficulty of such work but claims that results achieved so far certainly warrant its continuance. Unless public support is forthcoming, however, it seems that the experiment will have to end. Ecological research (which is what this is) must, of necessity, be long-term, and meanwhile the problem grows increasingly urgent. Here is an experiment—apparently the only one of its kind in Britain—which has the first sixteen years work already accomplished; whether or not it ultimately provides the answer, it can scarcely be shrugged aside as of no importance.

Tranquillizing Drugs in the United States

Tranquillizing drugs include reserpine (an alkaloid from *Rauwolfia serpentina*) and a variety of synthetic compounds such as chlorpromazine and

meprobamate. A few years ago drugs of this type began to be used in mental hospitals to bring patients under control and make them fit for other therapy. Later they came to be prescribed in private practice in the treatment of patients seeking relief from anxiety and tension. In the United States their use has increased to such an extent that it is estimated that about 35 million prescriptions for them were written in 1956. At present, 5–10 per cent of all prescriptions in New York City are for tranquillizers, and their use is increasing. Used under proper control, the tranquillizers are exceedingly useful drugs, but it appears that the public are taking them in great quantities for the relief of nervousness, emotional upsets and the routine tensions of daily life. This constitutes a danger to public health, for these drugs can have harmful side effects. They may cause jaundice, Parkinsonism, agranulocytosis and may induce severe depressive reactions which sometimes lead to suicide.

The Committee on Public Health of the New York Academy of Medicine recently issued a "Report on Tranquilizing Drugs" (pp. 16, 1956), which makes recommendations on the need for stricter control of their sale to the public. The Committee believes that the excessive and uncontrolled use of the drugs is due not so much to sale without prescription, but to the re-filling of prescriptions without the sanction of the doctor. Under the Sanitary Code of New York City this is perfectly legal for these drugs (though not for the sulphonamides, barbiturates or narcotics). The Committee recommends, first, that the Sanitary Code should be tightened up to permit the sale of new, potentially harmful or habit-forming drugs only on a prescription which cannot be repeated except on the order of the original prescriber. The second recommendation is that the Board of Health should survey the literature sent out by the manufacturers of the tranquillizing drugs, as a first step towards ensuring that proper information is given on the dangers of side reactions and on the necessary precautions, and that extravagant and uncritical claims and misrepresentations are removed. The Committee considers that the American lay press, which often refers to these drugs as "happiness pills", has contributed to the dissemination of premature and incomplete accounts of their effects.

Nutrition of *Phytophthora*

Mycologists have long been aware of the fact that species of *Phytophthora* are particularly difficult to culture on synthetic media. This difficulty was partly overcome when it was found that thiamine was an essential ingredient, and, indeed, appears to be the only vitamin required. L. E. Lopatecki and W. Newton have now presented a study of *Phytophthora* in which the nutrient requirements of several species have been investigated (*Canadian J. Bot.*, **34**, 5, 751; 1956). *Phytophthora cactorum* grew well in ammonium-salt media but not in nitrate. Conversely, *P. megasperma* grew well in nitrate but not in ammonium-salt media. *P. parasitica* and *P. erythroseptica* grew well in both, but better in that containing nitrate. All species grew better in the presence of organic nitrogen. Evidence is presented that iron, zinc, copper and manganese are essential trace metals and that zinc is required in greater concentrations than iron. The optimum requirement for glucose or sucrose was found to be approximately 4 per cent, and the residual sucrose was converted into reducing sugars by all species except *P. cactorum*. Approximately 50 per cent of the residual sugar remained unchanged in the cultures of this species. The growth-rate and sugar consumption increased as the thiamine-level was increased from 0·2 to 0·8 mgm. per litre, but the coefficient of sugar utilization remained constant. On the other hand, the percentage of nitrogen in the mycelium decreased markedly as the thiamine content of the medium was increased. It is concluded that with media containing 1 per cent alanine an accurate bioassay of thiamine can be made over a concentration range of 0·2–0·6 mgm. per litre. In a further contribution (*ibid.*, p. 759) W. Newton has described investigations relating to the non-utilization of *d*-alanine and growth stimulation by *l*-alanine in the nutrition of *P. parasitica*.

Bernice P. Bishop Museum, Hawaii: Report for 1955

The report for 1955 of the Bernice P. Bishop Museum, Hawaii (pp. 46; 1956), is attractive and unorthodox. The title "A Museum Point of View" is naturally arresting, and a striking cover features a Hawaiian war god in colour. The introduction stresses that a museum is the expression of a point of view towards education and that its visitors are willing to submit themselves to new ideas, impressions and knowledge. Museums should be the principal means to stimulate the alert, imaginative and curious mind. As with the majority of museums at the present time, a long-term policy was adopted in 1953; and 1955 witnessed another stage in the work, for during the year a total of twenty-two new exhibits were arranged to illustrate the story of Ancient Hawaii. In addition, the Hawaiian Court of the Museum has been landscaped as a living exhibit of plants important to the early Hawaiians. Modern display and good lettering have been adopted in all these new exhibits. An impressive list of publications by the staff records the recognition of research as an important function of museums.

Submicroscopic Organization and Function of Nerve Cells

An invited conference is to be held on this subject under the auspices of the International Society for Cell Biology at the Venezuelan Institute for Neurology and Brain Research (see *Nature*, 176, 1049; 1955) during March 15–22. The symposium, which has been organized by the director of the Institute, Dr. H. Fernandez-Moran, is supported financially by the Venezuelan Government. The conference will discuss the structure and functions of the nerve fibres, the nerve cell membrane, the neuron, the synapses and receptors and will centre around the fields of ultrastructure, bioelectric activity, biochemistry and histochemistry of nerve tissue. Representatives of ten countries will attend the conference, and those from the United Kingdom include Dr. G. H. Bourne, Prof. J. de Castillo, Prof. C. G. Causey, Prof. J. Elkes, Prof. J. B. Finean and Prof. J. T. Randall. The proceedings will be published in book form by the International Society for Cell Biology. Requests for copies of the proceedings should be sent to Dr. H. Fernandez-Moran, Director del Institute Venezolano de Neurologia e Investigaciones Cerebrales, Ministerio de Sanidad, Caracas, Venezuela, South America.

Oversea Service Division: Colonial Office

The following appointments have recently been made in the Oversea Service Division of the Colonial

Office: T. A. R. Choate (forester, grade 1, Kenya), assistant conservator of forests, Kenya; A. J. L. Mitchell (assistant conservator of forests, Western Region of Nigeria), senior assistant conservator of forests, Western Region of Nigeria; J. K. Ross (senior assistant conservator of forests, Western Region of Nigeria), conservator of forests, Western Region of Nigeria; R. B. McConnell (director of Geological Survey, Bechuanaland), director of the Geological Survey, British Guiana; J. C. Alley (veterinary officer, Tanganyika), veterinary officer, Aden; D. H. Mackenzie, temporary field geologist, Sierra Leone; A. D. H. Bivar, assistant surveyor, antiquities, Federation of Nigeria; Miss M. M. Bools, assistant bacteriologist, Barbados; K. M. Cripps; meteorologist, Cyprus; D. Kay, plant pathologist, West Africa Cocoa Research Institute, Gold Coast, D. A. Lury, statistician, East Africa High Commission; A. Pinkerton, soil surveyor, Kenya; H. Roberts, entomologist, West African Timber Borer Research Unit, Gold Coast; C. T. Stratton, statistician, Hong Kong; J. P. Tunstall, senior scientific officer, Nyasaland.

Postgraduate Scholarships in Agriculture

The Ministry of Agriculture, Fisheries and Food and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, 1957, a number of postgraduate scholarships in agricultural economics, the various branches of husbandry, farm management, statistics, agricultural and dairy engineering, rural estate management and land economics. The closing date for receipt of completed application forms is March 31. Further particulars and forms of application can be obtained from the Secretary, Ministry of Agriculture, Fisheries and Food, Room 286, Great Westminster House, Horseferry Road, London, S.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

Announcements

The United Kingdom Atomic Energy Authority will open an office at Dodoma, Tanganyika, in April. This office will give technical advice to prospectors on the search for uranium ore in East Africa. It will include a laboratory equipped for sample assaying. The Authority has already established a similar office in Salisbury to service the Federation of Rhodesia and Nyasaland.

Arrangements have been made for the Iron and Steel Institute and the Institute of Metals to become members of the British Nuclear Energy Conference, and for each Institute to be represented on the Board of the Conference by three members. The purpose of the British Nuclear Energy Conference is to co-ordinate the activities of the constituent members in the field of nuclear energy by holding meetings and publishing a *Journal*. The original constituent members were the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Electrical Engineers, the Institute of Physics and the Institution of Chemical Engineers.

The Trustees of the Ramsay Memorial Fellowships Trust will consider in June applications for two Fellowships for advanced students of chemistry. One of the Fellowships will be limited to candidates educated in Glasgow, who can apply to be considered for either Fellowship. The value of each Fellowship, which will normally be tenable for two years, will be £600 per annum, to which may be added a grant for expenses of research not exceeding £100 per annum. Full particulars can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College London, Gower Street, W.C.1. Completed application forms must be received not later than April 18.

The annual Conference of the Institute of Metal Finishing, in which is incorporated the Electrodepositors' Technical Society, is to be held at the Grand Hotel, Brighton, during April 9–13. Further details may be obtained from the Conference Secretary, Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

A joint symposium of the Koninklijk Instituut van Ingenieurs, the Koninklijke Nederlandse Chemische Vereniging, the Society of Chemical Industry and the Institution of Chemical Engineers is to be held at Church House, Westminster, on May 28 and 29, on the "Scaling-up of Chemical Plant and Processes". Members of the sponsoring bodies can obtain further details from their respective Secretaries; others should write to the General Secretary, Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1.

The Scottish Group of the Nutrition Society is holding a symposium on "Clean Food" in Aberdeen on April 20. Papers to be read deal with the bacteriology and public health aspects of food poisoning, the inspection of food, protection of food at home and by catering concerns, some clinical consequences of food poisoning, and the spoilage of fish. Further particulars can be obtained from Dr. J. Davidson, Rowett Research Institute, Bucksburn, Aberdeenshire.

The Arbeitsgemeinschaft Deutsche Kunststoff-Industrie, in association with Kunststofferzeugende Industrie und verwandte Gebiete e.V. and Gesamtverband kunststoffverarbeitende Industrie e.V., together with the German Physical Society, the German Chemical Society, the Deutsche Normenausschuss and the Verein Deutscher Ingenieure, are to organize a Plastics Conference at Bad Pyrmont during April 10–11. Further information can be obtained from the Conference Organizing Committee, Frankfurt am Main 1, Karlstrasse 21.

A symposium organized by the Division of Plastics and High Polymers of the International Union of Pure and Applied Chemistry, on the subject of the relationship between the physical chemistry and the testing (with special reference to standardization) of elastomers, fibres and plastomers, based on their structure, is to be held in Paris during July 25–26. Further details can be obtained from the secretary, Prof. P. Dubois, 292 rue St.-Martin, Paris 3.

The Cornell Summer Laboratory Course in Techniques and Applications of the Electron Microscope will be given during June 17–29 by the laboratory of electron microscopy in the Department of Engineering Physics, Cornell University. This course, which is intended primarily for workers in the fields of physics, chemistry and metallurgy, is under the direction of Prof. B. M. Siegel, and all inquiries should be addressed to him at the Department of Engineering Physics, Cornell University, Ithaca, New York.

Messrs. BX Plastics, Ltd., point out that 'Styrafoil', mentioned in *Nature* of February 9, p. 322, is not a form of 'Cellophane', but an orientated polystyrene film.

SCIENTIFIC RESEARCH AND ITS ORGANIZATION

IN the course of the first Ludwig Prandtl Memorial Lecture, delivered before the German Scientific Society for Aeronautics (W.G.L.) at Göttingen on February 4, Prof. Albert Betz strongly urged certain changes in the approach to scientific research in the Western world. Prof. Betz, of the University of Göttingen, a distinguished aerodynamicist and probably the oldest active representative of the Göttingen school of physics, was the closest collaborator of the late Ludwig Prandtl. He spoke on "Fifty Years of Research in the Field of Fluid Dynamics", and his critical survey of past achievements culminated in two specific reproaches.

The first was directed against the mathematicians, who have taken too little interest in providing truly comprehensive theories in fluid dynamics. Such general treatment would save expensive *ad hoc* experimentation for purposes of aeronautical engineering. It seemed to him that the spirit of Felix Klein (founder of the famous school of theoretical physics at Göttingen) is no longer alive among mathematicians. Klein, himself a mathematician, had conceived of the mathematicians as acting as a sort of 'general staff' for the engineering sciences. But mathematicians to-day seem to shirk tackling problems from other domains, in particular those of applied physics. The second criticism of the development of fluid dynamics concerned the lack of really gifted physicists who could analyse a complicated question and solve the component problems in a way which, after re-constitution, would yield comprehensive solutions to the original problem.

In general, mass production and mechanization have been introduced into scientific research, with dire consequences for the quality of the output. Expensive laboratory equipment (which might often be replaced by much cheaper and simpler devices) and numerous staff, with automation and electronic processing of the results, have helped relatively little to stimulate genuine advance, except in detail and over *ad hoc* problems.

The size and variety of experimental equipment, for example, the gigantic modern wind-tunnels, have called for mass-production of scientists to handle it. Since only a small percentage is really sufficiently gifted to achieve progress in research, a 'scientific proletariat' has thus been created. This has cluttered up the pages of periodicals and filled the days of congresses with mediocre contributions. It has also affected the quality of the teaching and depressed the standards of colleges and universities. Worst of all, members of this scientific proletariat have managed to find their way to the handling of problems for which they are unsuited. In this way, gifted research workers are kept out, or have shirked the responsibility. Training of the mass of scientists has often been reduced to mere cramming for examinations. It should not be forgotten that the level of intelligence is decreasing in the Western world. Under the influence of press, radio, cinema and television, the ability to think independently and along scientific lines has become rare. It is just that faculty which the research scientist needs most.

Gifted scientists are too little attracted by research, and frequently too much impressed by large institutes and elaborate facilities for experimenting. In the majority of instances, progress in basic research needs a few carefully chosen experiments with rather simple devices. Size and complication of the laboratory equipment are often a disadvantage. Even more important are the conditions under which a scientist has to work. Research cannot be conducted effectively when the scientist is expected to produce results to order; he should be left free to investigate those problems to which he is most attracted. Betz recalled the habit of Prandtl 'playing', by repeating an experiment time after time with minute variations. It was, of course, an essential part of his research to study the phenomena closely and to correlate them with each other, before drawing conclusions. Under pressure of work and hustling, such fruitful research could not be done.

Gifted research workers should not be directed into the administration of large research institutes. There was the apt advice on how to prevent a scientific rival from forging ahead: this was to get for him a large institute, the administration of which would rapidly put an end to his research productivity. Research workers might advise in the direction of scientific output, but they should not head such institutions.

It is most important to free research scientists from oppression by bureaucracy. Bureaucracy has encroached more and more on the domains of science. This interference with the conduct of research presents a grave danger, and the process should be reversed as soon as possible. The progress of science should not be interfered with by the instantaneous needs of industry or by the requirements of the Services. The scientist should be left free to spend his means for research in the way that he judges best.

The U.S.S.R. has now become a formidable rival in the field of scientific progress. Research was sponsored, equipped and conducted on an exemplary scale. The training facilities left little to be desired. The system of regimentation is totally unacceptable to Western civilization, and Prof. Betz thought that, in the end, the free research scientist would forge ahead of anyone who worked under compulsion and direction. But the attitude towards research in the West requires re-orientation: the scientist's needs deserve more consideration. It should not be forgotten that nowadays not the quantity of weapons but the quality of the scientists mattered most.

Concluding, Prof. Betz recalled W. v. Harnack's dedication when handing over to L. Prandtl the new Institute for Fluid Dynamics in 1925, on behalf of the Kaiser-Wilhelm Society for the Promotion of Science: "Our task is to select the research scientist, and we do so with the utmost care. If we have found him, we provide him with as much money and all the means necessary to conduct his research. *This is the end of our task.* It is left to the scientist to spend the money and to apply the means as he judges best. We do not interfere". After all these years of the Göttingen Institute, Prof. Betz commented, it has become obvious how sensible this approach to research has been.

A. R. WEYL

EXAMINATION OF LONDON WATERS

THE latest report of the Director of Water Examination of the Metropolitan Water Board* re-emphasizes the close control which is necessary in a large water undertaking drawing its supplies mainly from polluted or potentially polluted rivers. For routine control of water quality, some 45,000 samples are examined each year, and in addition the Board carries out a wide range of chemical, biological and engineering research, both in the laboratory and in large-scale experimental plant. One of the chief objects of the bacteriological research is to reduce the period necessary for confirming the presence in water of *Bacterium coli* Type I, a test which is of great importance in deciding whether a water is bacteriologically safe; in the majority of cases the whole test can now be carried out in thirty hours. The possibility of making a further big reduction in this period—in devising, in fact, a bacteriological test comparable with a chemical determination—would seem to depend on the discovery of some technique quite different from the present method of incubating samples in selective media at a controlled temperature.

A detailed account is given of the measures taken by the Board to sterilize jute yarn, of which some ten tons are used every year as a packing material in the jointing of mains. Many types of bacteria, including some pathogenic organisms, grow rapidly on this yarn; for example, *Salmonella paratyphi B* multiplied 40-fold within two days on yarn immersed in water at 22° C. Before being used, therefore, the yarn is sterilized; it is washed in chloride-free water and is then treated with a solution of phenyl mercuric borate, this compound being fixed on the yarn by immersing it in a 6 per cent solution of sodium chloride; after treatment, samples of the yarn are examined in the laboratory for sterility. As a result of adopting this method, the proportion of bacteriologically unsatisfactory samples of water from repaired mains has been reduced from about 32 per cent to 6 per cent.

Several interesting examples are given of the introduction of automatic recording and controlling equipment, as a result of which some stations at which water is pumped from wells and chlorinated are now operated without a plant attendant being always present; data on the working of the plant are recorded by electrical connexion at a central station, and there are automatic devices to shut off the pumps if, for example, the concentration of chlorine in water passing into supply deviates by more than a chosen amount from a mean value. The report records considerable progress in the automatic control of chlorination, the quantity being regulated by the rate of flow of water, and by its chlorine demand. Another interesting advance has been the development of equipment to record the thermal stratification of a reservoir. When stratification breaks down, the water passing into supply may for a time be of poor quality, and it is necessary, therefore, to have immediate warning of the change so that remedial measures can be brought into operation at once.

Some little time ago there was a report that drinking waters in some parts of Britain contained undesirably high concentrations of copper. It is interesting, therefore, to know that in the whole of the area served by the Metropolitan Water Board there were, in 1953, ten complaints, and in 1954 twenty-one complaints of discoloured water thought to be due to the presence of copper. When these cases were investigated the supply was always found to be from an underground source, the water being taken to the consumer's premises in a copper pipe. The concentration of copper in the water from the main supply was usually from 0·1 to 0·2 part per million. It has been shown that with hard water similar to that in the London district, corrosion of copper—which is associated with the presence of films of carbon or copper oxide formed on the metal during manufacture—is limited or prevented by the presence of small quantities of an inhibitory substance which is present in surface waters but not in well waters.

Experiments with large-scale plant have been made on the treatment of water with coagulants. The results indicate that there is a strong case for adopting the use of activated silica in addition to aluminium sulphate; use of the silica has not made any marked improvement in the removal of algae, but it does give a denser and more rapidly formed floc and so improves the subsequent process of filtration. A process has been worked out for reclaiming coagulant from sludge, which is air-dried, roasted and extracted with sulphuric acid to yield a solution of aluminium sulphate which can be re-used.

B. A. Southgate

* Metropolitan Water Board. Thirty-sixth Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the years 1953–1954. By Dr. E. Windle Taylor. Pp. 74+3 plates. (London: Staples Press, Ltd., 1956.) 15s. 6d.

REGIONAL ADVISORY COUNCILS FOR TECHNICAL AND FURTHER EDUCATION IN BRITAIN

THE origin and main purposes of regional advisory councils for technical or further education were described in the White Paper on "Technical Education" presented to Parliament by the Minister of Education in 1956.

In England nine councils were voluntarily established by their constituent local education authorities and are financed by them in proportion to their populations. This is in contrast to the position in Scotland, where five regional advisory councils for technical education—based on Aberdeen, Dundee, Edinburgh, Glasgow and Inverness, respectively—were statutorily established in April 1948 and financed from the Exchequer.

Most regional councils advise on all forms of further education, but in London the council is concerned with technology, commerce and industrial design and, primarily, with advanced work.

Much of the most valuable work of regional advisory councils is done on industrial advisory committees on which representatives of regional bodies of employers and operatives in a very wide variety of industries meet educational representatives to plan developments from the point of view of the region as a whole.

The nine English councils and their academic boards are constituted to a common pattern, with representatives on the council from constituent local

education authorities, universities and university colleges, technical institutions and industry. The academic boards have stronger representation of universities and technical institutions. The Ministry of Education appoints assessors to all the councils and boards, and provision is often made for other Ministries to be represented.

Details of the constitution and functions of regional advisory councils have been set out in a pamphlet* together with a list of local authority areas included in each region. Copies can be obtained from the London Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1.

T. H. HAWKINS

* Constitution and Functions of Regional Advisory Councils and Local Authority Areas included in each Region. Pp. 12. (London: Regional Advisory Council for Higher Technological Education, 1956.) 2s.

INSTRUMENTATION IN SCIENCE

IN recognition of the important part played by instruments in modern science, technology and business organization, the issue of *Science* of October 25, 1956, is largely devoted to instruments. There are eleven main articles, ranging from data processing for scientists and electronics for measuring human motions, to cryogenic instrumentation and phase microscopy. K. F. Heumann in his article on data processing maintains that scientists will require more assistance from machines in the matter of handling scientific data, and that techniques which have had recent, rapid development in business and accounting applications will prove most useful. He considers two such techniques—integrated data processing (IDP) and electronic data processing (EDP)—and refers to the 'Flexowriter', an electric typewriter equipped with a tape punch and reader; the IBM type 705 EDPM machine, a large-scale general-purpose data processor; and the UNIVAC File-Computer, a medium-size general purpose computer. In an article on cryogenic instrumentation, J. G. Daunt surveys recent progress in low-temperature technology, in particular, large-scale hydrogen and helium liquefaction plants; the separation of hydrogen isotopes by distillation; liquid hydrogen cooled electromagnets; bubble chambers; the magnetic refrigerator; and the thermal rectifier for use below 1° K. In the field of high-temperature research, solar energy is superior to any other form of energy presently available, and T. S. Laszlo's article describing the various forms and advantages of solar furnaces is most valuable, though only a few such furnaces have so far been constructed. "Fixed-Field Alternating Gradient Accelerators", by L. J. Laslett, deals in some detail with the recent new developments in the high-energy particle accelerator art which are mainly the results of study by members of the Mid-Western Universities Research Association.

An important new branch of technology encompassing the analysis, testing and processing of materials and products by the use of mechanical vibrating energy was named 'sonics' by R. H. Bolt and T. F. Hueter about two years ago, and in his article, "Sonic Techniques in Industry", T. F. Hueter gives a most instructive and illuminating survey of the basic physics involved and of the many fields of application ranging from oil-well drilling to medical therapy and molecular analysis. Other articles deal with a new principle of closed-system centrifugation developed at the Harvard Medical School, Boston, and chiefly applied in the blood field, though it has equal application to virus purification, milk stabilization, and the separation of other multiphase systems; low-level counting methods for isotopic tracers; the design study of a megacurie source; the 'Bendix' time-of-flight mass spectrometer; a device for measuring the performance of people at various work activities using the Doppler effect with sound, called a Universal Operator Performance Analyser (UNOPAR), and operating at 20 kc./s., which is just above the human threshold of hearing at normal levels of intensity; and finally, a review, including an extensive bibliography of 178 items, of published work on phase microscopy during 1954–56.

AGRICULTURAL METEOROLOGY IN GERMANY

TWO interesting publications on agricultural meteorology have recently been issued by the Weather Service of the German Federal Republic.

The first of them, "Vorträge über Frostschutz" (*Mitteilungen des Deutschen Wetterdienstes*, 3, No. 16; 1956), reports the first meeting of the Association for Protection against Frost, held in Bonn on November 22, 1955, and the Symposium of the Technical Experiences of the German Weather Service in Protection against Frost, held on April 26, 1956, at Mainz. The task of the Association, which was set up by the Ministry of Food, Agriculture and Forests, is to further collaboration between agriculturists and meteorologists in this important subject. The pamphlet contains a list of the meteorological offices and of the centres for research in agricultural meteorology and provision of advice on agricultural meteorological matters, from which it is noteworthy that of the twenty meteorological offices in West Germany, eight are devoted to agricultural matters and three of the others are also agricultural offices. At Stuttgart there are two meteorological offices, one of which is an agricultural office.

The meetings of the Association discussed the education of farmers in frost protection by talks by agricultural meteorologists and the issue of posters drawn up by the Weather Service, giving of advice to local councils on planning to minimize frost damage and the establishment by them of a frost protection officer, and research into frost protection methods and the effects of frost on different plants. The organization for giving warning of the onset of frost by broadcasts and special telegrams is described in detail. Papers read at the symposium described methods of shielding orchards and vineyards from cold katabatic winds by judicious planting of trees and building of walls, and gave a good deal of information on methods of protection by spraying water, heating by oil burners, preventing the formation of a stagnant cold layer near the ground by stirring it up with propellors and screening from radiation by smoke. Excellent diagrams of all these methods are given; those on the diversion of katabatic winds by shelter belts are particularly striking.

The second paper (*Berichte des Deutschen Wetterdienstes*, 5, No. 28; 1956) describes investigations by A. Baumgartner into the heat and water balance of a young pine forest near Munich. The author made measurements of radiation flux, temperature,

humidity, evaporation, wind and dew in, above and alongside the forest, and presents the results in great detail, including even a calculation of the energy used in photosynthesis. Observation shows that on sunny days the highest temperatures and major flux of radiation occur between the tops of the trees, this region forming the so-called 'elevated active surface'. A detailed energy balance sheet is constructed, from which it appears that on a sunny day 63 per cent of the solar radiation energy is used up in evaporation, 31 per cent returned to the air above the forest, and 2·5 per cent goes to warming the soil. This paper is a major work of micrometeorology.

G. A. Bull

RADIOSENSITIVE MOLECULAR WEIGHT OF TOBACCO MOSAIC VIRUS NUCLEIC ACID

By Dr. WILLIAM GINOZA and Prof. AMOS NORMAN

Atomic Energy Project and Department of Radiology, School of Medicine, University of California at Los Angeles

We have studied the X-ray inactivation of the infectious nucleic acid (ribonucleic acid)[1,2] of tobacco mosaic virus. The results indicate that the entire ribonucleic acid complement of the virus acts as a single infectious unit.

The ribonucleic acid was prepared by the method of Fraenkel-Conrat and Williams[3]. The physical, chemical and biological[1,4] behaviour of the material precluded the possibility that the observed results are due to tobacco mosaic virus contaminants. An X-ray tube with beryllium window operated at 50 kV. delivered $5{\cdot}3 \times 10^4$ r./min. at 10 cm. to the ribonucleic acid samples. 0·1-ml. samples at a concentration of about 5 mgm./ml. were pipetted into aluminium cups and frozen on a brass block partially immersed in a 'dry ice'–*iso*propanol bath. Alternatively, samples were dried on paraffin blocks over 'Drierite' in vacuum. Under these conditions of freezing or drying, the recovery of activity of the nucleic acid was in many cases almost complete. The X-ray inactivation dose was identical within the experimental error for samples under both conditions. Appropriate corrections were made for the thickness of the samples in computing the X-ray dose. Test and control samples were assayed within an hour or two after irradiation on *Nicotiana glutinosa*, using 16–24 half-leaves per sample.

The nucleic acid inactivation curve is presented on Fig. 1 (lower solid line). As shown by different symbols, the curve represents a composite of four separate experiments using four different preparations of nucleic acid. The 37 per cent survival dose (D_0) is $3{\cdot}0 \times 10^5$ r. We have calculated that ribonucleic acid will absorb 115 ergs/gm./r., at the wave-lengths of this X-ray beam[5]. But both in the dried and in the frozen material the photo-electrons that ionize the ribonucleic acid will come predominantly from the surrounding medium, which absorbs only about 85 ergs/gm./r. The figure of 110 eV./primary ionization has been well established for high-energy electrons[6]; but there is good reason for believing that a value approximately two-thirds of this is more appropriate for the low-energy photo-electrons produced in this irradiation[7]. Using 85 ergs/gm./r. and 73 eV./primary ionization leads to a molecular weight of $2{\cdot}7 \times 10^6$. The individual experiments give a range of molecular weight between $2{\cdot}1$ and $4{\cdot}0 \times 10^6$.

It is of interest that no polydispersity with respect to irradiation sensitivity is indicated by the results. The single slope found implies that the infectivity is carried by particles having identical molecular weight. This is in contrast to the results with the transforming principle[8,9].

If the nucleic acid is either frozen or dried in the presence of 2 per cent glutathione, a two-fold decrease in the radiation sensitivity is observed as indicated by the dotted curve (Fig. 1). Calculations on the basis of these results give a molecular weight of $1{\cdot}0 \times 10^6$. However, since there is no indirect effect in the dry material, it would appear that glutathione modifies the direct effect of radiation, thus leading to an under-estimate of the molecular weight. Support for this interpretation of the glutathione effect comes from the work of Alexander and Charlesby[10], who have shown that thiourea and other compounds modify the direct effects of ionizing radiations on dried films of polymethylmethacrylate.

The results of our X-ray inactivation of the parent tobacco mosaic virus from which the nucleic acid was derived are summarized in Fig. 2. The conditions chosen for irradiation were the same as those employed for the nucleic acid. The D_0 of $3{\cdot}0 \times 10^5$ r.

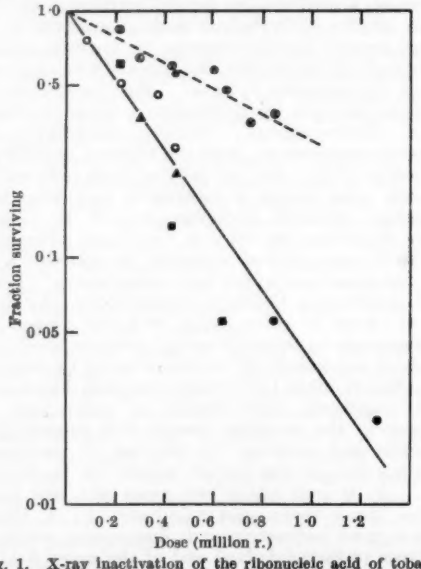


Fig. 1. X-ray inactivation of the ribonucleic acid of tobacco mosaic virus. The survival curve (lower solid line) represents a summary of four separate experiments using frozen or dried samples. The upper broken line shows the effect of glutathione in frozen or dried samples

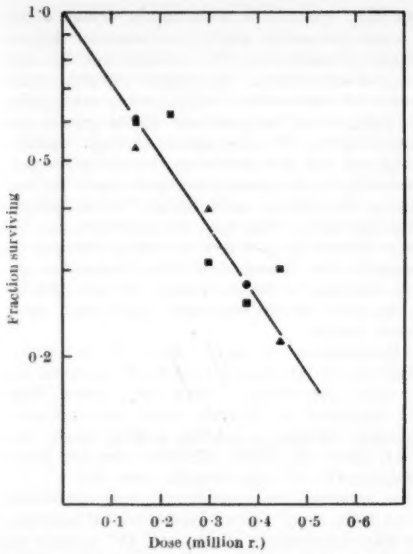


Fig. 2. X-ray inactivation of tobacco mosaic virus. The curve represents a summary of three separate experiments (frozen or dried samples) as indicated by different symbols

for the virus is identical within the experimental error with that found for the nucleic acid. This suggests strongly that the X-ray inactivation of tobacco mosaic virus is the consequence of the inactivation of the nucleic acid, as proposed by Epstein[11] and by Lauffer, Trkula and Buzzell[12]. Indeed, it now appears that the protein component of the virus is not essential to the infectious process[1], a finding which is consistent with the earlier studies showing that this shell can be subjected to various chemical alterations without inactivating the virus[13].

From the present results, it can be concluded that the radiosensitive molecular weight of the infectious nucleic acid of tobacco mosaic virus is about 2·7 million. Allowing a factor of two as the uncertainty involved in our method of estimation, primarily because of the uncertainty in the figure[6,7] of 73 eV./primary ionization, a molecular weight range of 1·4–5·4 million is obtained. Chemical analyses indicate that the molecular weight of the virus ribonucleic acid, assuming total ribonucleic acid to be a single molecule, is between 2 and 3 million. This range for the total ribonucleic acid is in the middle of the range estimated for the infectious ribonucleic acid. Thus the results indicate that the total ribonucleic acid complement of the virus behaves as a single infectious unit.

Preliminary electric birefringence measurements also support the view that the ribonucleic acid has the same structure in solution as in the virus. First, the sign of the birefringence is positive as it is in the virus[14], indicating that the bases are parallel to the long axis of the molecule. Secondly, the magnitude of the birefringence is such as to suggest a highly ordered structure. Thirdly, the relaxation time exhibited by the molecule indicates a length very close to that of the virus itself. The results of Hopkins and Sinsheimer[15] also indicate that the total viral ribonucleic acid is extracted as a single unit.

We are grateful to Drs. Albert Siegel and Samuel G. Wildman for their interest in, and support of, this work, and to Miss Carol J. Hoelle for technical assistance. We are also indebted to John A. Field, jun., for his assistance in performing the electric birefringence measurements.

This communication is based on work performed under Contract *AT*-04-1-*GEN*-12 between the Atomic Energy Commission and the University of California at Los Angeles.

[1] Glerer, A., and Schramm, G., *Nature*, **177**, 702 (1956).
[2] Fraenkel-Conrat, H., *J. Amer. Chem. Soc.*, **78**, 882 (1956).
[3] Fraenkel-Conrat, H., and Williams, R. C., *Proc. U.S. Nat. Acad. Sci.*, **41**, 690 (1955).
[4] Siegel, A., Wildman, S. G., and Ginoza, W., *Nature*, **178**, 1117 (1956).
[5] Norman, A., and Greenfield, M. A., *Radiation Research*, **3**, 407 (1955).
[6] Pollard, E. C., Guild, W. R., Hutchinson, F., and Seltow, R., "Progress in Biophys.", **5**, 72 (1955).
[7] Buzzell, A., Trkula, D., and Lauffer, M. A., *Archiv. Biochem. and Biophys.*, **63**, 470 (1956).
[8] Ephrussi-Taylor, H., and Latarjet, R., *Biochim. Biophys. Acta*, **16**, 183 (1955).
[9] Marmur, J., and Fluke, D. J., *Archiv. Biochem. Biophys.*, **57**, 506 (1955).
[10] Alexander, P., and Charlesby, A., *Nature*, **173**, 578 (1954).
[11] Epstein, H. T., *Nature*, **171**, 394 (1953).
[12] Lauffer, M. A., Trkula, D., and Buzzell, A., *Nature*, **177**, 890 (1956).
[13] Miller, G. L., and Stanley, W. M., *J. Biol. Chem.*, **141**, 905 (1941). Knight, C. A., Cold Spring Harb. Symp. Quant. Biol., **12**, 115 (1947).
[14] Franklin, R. E., *Biochim. Biophys. Acta*, **18**, 313 (1955).
[15] Hopkins, G. R., and Sinsheimer, R. L., *Biochim. Biophys. Acta*, **17**, 476 (1955).

RADIOCHEMICAL DEGRADATION OF DL-METHIONINE

By JAROSLAV KOLOUŠEK, JINDŘICH LIEBSTER and ARNOŠT BABICKÝ
Physiological and Biological Institute of the Czechoslovak Academy of Sciences, Prague

THE effect of ionizing irradiation on organic compounds[1–3], and especially on amino-acids[4–9], has been extensively studied. In spite of its biological importance in biology (metabolism, especially proteosynthesis), the radiochemistry of methionine has not been studied in detail. In connexion with some biochemical problems we are interested in, we considered it necessary to elucidate the mechanism of the radiochemical degradation of methionine.

For our experiments the following methods were used. Solutions were analysed by one- and two-dimensional filter-paper chromatography on Whatman No. 1 paper. In one-dimensional chromatography, *n*-butanol/acetic acid/water mixture (4 : 1 : 5) was used. In some cases a 0·2 per cent solution of thiodiglycol was added to prevent oxidation. In two-dimensional chromatography the above mixture was used in the second direction and a phenol/ethanol/water mixture (2 : 1 : 1) containing 0·1 per

Fig. 1

Fig. 2

Fig. 1. Autoradiogram corresponding to DL-methionine-^{35}S and its degradation products

Fig. 2. One-dimensional chromatogram of a solution of: *A*, pure DL-methionine; *B*, methionine irradiated with X-rays 10^5 r., on Whatman No. 1 filter paper, developed four times in *n*-butanol–acetic acid–water (4 : 1 : 5) and detected by 0·1 per cent ninhydrin solution. Spots: 1, methionine; 2, methionine sulphoxide; 3, homocysteine; 4, 6, 7, unidentified; 5, methionine sulphone

cent 8-hydroxyquinoline in the first direction. The chromatogram was developed up to overflow (indicator tropeolin 000). Filter-paper electrophoresis was carried out according to the procedure described by Mikeš[10].

Solutions of methionine and other compounds of equal concentrations (0·5 per cent) were irradiated in 1-mm. layers in 'Plexiglass' cuvettes. As X-ray source a Machlett *AEG* 50 tube with a beryllium window at 50 kV. and 50 m.amp. with a 0·05 aluminium sheet filter was used. The beta-ray source was 30 mc. radium-D,E,F in equilibrium, corresponding to 5,000 r./hr.

Purified inactive methionine gives two spots on the paper chromatogram, corresponding to methionine and methionine-sulphoxide. Addition of a 0·2 per cent thiodiglycol solution to the solvent does not change the chromatogram except for preventing the formation of a stripe between the methionine and methionine-sulphoxide spots.

DL-Methionine-^{35}S (from the U.S.S.R., spec. act. 800 mc./gm.) gives six ninhydrin-positive spots on the filter-paper chromatogram and seven intense spots on the autoradiogram. The radioactivity of the spots was measured by a Geiger–Müller tube and evaluated graphically. Thus methionine-^{35}S contained: methionine-^{35}S 67·1 per cent, methionine-^{35}S sulphoxide 20·2 per cent, homocysteic acid-^{35}S 5·2 per cent; the sum of the other spots amounted to 7·5 per cent of the total radioactivity. From start to front runs a strip of slight radioactivity.

DL-Methionine-^{35}S chromatographed two-dimensionally ten days after dissolving gave rise to three spots detectable by ninhydrin and twelve spots detected by autoradiography. Obviously deamination occurs very quickly in this highly active compound and some primarily ninhydrin-positive degradation products of methionine-^{35}S undergo further degradation by deamination. By paper electrophoresis the presence of one acidic compound corresponding to homocysteic acid was proved. Homecysteic acid was detected on the chromatogram as well. Addition of thiodiglycol did not influence the chromatogram.

To clarify the origin of the impurities or degradation products, the above methionine-^{35}S was purified by chromatography. The spot belonging to methionine-^{35}S was eluted and chromatographed anew. It was developed four times, and after detection by ninhydrin six spots were observed. By autoradiography the identical spots appeared plus one spot not detected before.

DL-Methionine-^{35}S (spec. act. 23 mc./gm.) synthesized in our laboratory showed three spots immediately after dissolving. Four days after dissolving there appeared a fourth spot corresponding to methionine sulphone. After a few more days the solution gave the same chromatographic picture as methionine-^{35}S of high specific activity.

Pure inactive DL-methionine was irradiated by X- and beta-rays. To obtain a radiochemical effect by X-ray irradiation a dose of 10^6 r. was needed. The chromatogram showed spots for methionine, methionine-sulphoxide and homocysteine; with a dose of 10^7 r. seven spots could be detected by ninhydrin. Besides the above-mentioned compounds, methionine-sulphone was detected. At a dose level of 10^8 r. we obtained a picture identical to that at 10^7 r. By two-dimensional chromatography there were detected two spots in the acidic amino-acid position.

With beta-rays the first sign of degradation was the appearance of a spot corresponding to homocysteic acid observed at 2×10^3 r. At 10^4 r. we obtained six spots on the chromatogram: homocysteine, methionine-sulphoxide, methionine-sulphone, methionine and two unidentified compounds.

By these irradiation-degradation experiments it was proved unequivocally that the chromatographically detected degradation compounds of methionine-^{35}S are true products of radiochemical decay.

The mechanism of the radiochemical reaction could be further elucidated by studying the radiochemical decomposition of homocysteine. Homocysteine-^{35}S (23 mc./gm.) chromatographed immediately after synthesis showed homocysteic acid, homocysteine and two unidentified spots. Irradiation of inactive homocysteine solutions by X-rays (10^6 r.) gave rise to nine spots detected with ninhydrin. The spots with low and high R_F values correspond to the spots obtained with homocysteine-^{35}S. From start to front runs a ninhydrin-positive strip corresponding to the stripe observed on chromatograms of highly radioactive methionine-^{35}S.

On the two-dimensional chromatogram of homocysteine irradiated by X-rays we observed twelve spots. The unirradiated compound gave four spots. DL-Methionine sulphoxide gave the same chromatogram upon irradiation as methionine. With DL-methionine sulphoximine no degradation could be observed under similar treatment.

The experimental results presented above prove the radiochemical degradation of methionine. The degree of degradation is proportional to the irradiation dose. There is no basic difference in the products of the radiochemical reaction caused by the beta-rays from methionine-^{35}S itself and the irradiation of

DL-methionine by beta- and X-rays. There are essentially three routes for the radiochemical decomposition of methionine. By demethylation homocysteine is produced which is further oxidized by free radicals from water. Parallel to this reaction there occurs deamination, as proved by the increase in ninhydrin-negative spots. By the third type of reaction methionine is oxidized to its sulphone. Comparing the chromatograms of methionine-^{35}S, homocysteine-^{35}S and of the corresponding inactive compounds we reach the conclusion that demethylation is the important radiochemical reaction causing the decomposition of methionine and opening the path for further degradation. Of all types of irradiation the beta-rays from methionine-^{35}S are most efficient. To obtain comparable effects, far greater doses of X-rays have to be employed than of beta-rays.

[1] Dale, W. M., *Biochem. J.*, **36**, 80 (1942); *Brit. J. Radiol.*, **16**, 171 (1943); *ibid.*, Supp. No. 1, 46 (1947).
[2] Dale, W. M., and Davies, J. V., *Nature*, **163**, 64 (1949).
[3] Allsopp, C. B., *Trans. Farad. Soc.*, **40**, 79 (1944); *Brit. J. Radiol.*, **21**, 242 (1948).
[4] Stein, G., and Weiss, J., *Nature*, **162**, 184 (1948).
[5] Stein, G., and Weiss, J., *J. Chem. Soc.*, 3256 (1949).
[6] Dale, W. M., Davies, J. V., and Gilbert, C. W., *Biochem. J.*, **45**, 93 (1949).
[7] Swallow, A. J., *J. Chem. Soc.*, 1334 (1952).
[8] White, W., *Arch. Biochem. Biophys.*, **47**, 225 (1953).
[9] Chenoch, M. A., and Lapinskaja, E. M., *Doklady Akademie Nauk S.S.S.R.*, **102**, 993 (1955).
[10] Mikeš, O., *Chemické Listy*, **51**, 138 (1957).

A PRELIMINARY ANALYSIS OF THE STROBOSCOPIC PATTERNS

By J. R. SMYTHIES

The Psychological Laboratory, Cambridge

THE stroboscopic patterns are the sensory patterns that can be observed on looking at a suitable flashing light. The fact that coloured patterns may be observed by looking at flickering lights is mentioned by Helmholtz[1], Edridge-Green[2], and by Adrian and Matthews[3]. But the patterns themselves were first described by Brown and Gebhard[4] and Grey Walter[5], who suggested that they offered evidence for his theory of scanning processes in the nervous system. More recently, a brief description has been given by Massucco[6], and Blum[7] has used them in a study of schizophrenia and brain injury. The present communication reports some preliminary findings of a comprehensive study of these phenomena.

(1) *The natural history of the patterns.* The method used has been to illuminate the subject's retina with a large uniform flickering field and to record his verbal reports of the phenomena developing in his visual field using a wide range of parameters of stimulation. There were thirty-three subjects. The following facts were discovered.

The range and type of patterns reported by one individual were very constant for that individual over many months. There were also wide individual variations, both as to the dominant types and range of patterns reported, although these variations lay within certain well-marked limits.

Common patterns were as follows: those based on straight lines, for example, checker-boards, grids, tartans, sets of parallel lines—horizontal or vertical—and herring-bone patterns; patterns based on curved lines or closed curves, for example, spirals, whirlpools, vortices, catherine wheels, sets of concentric circles, families of parabolas or sine waves and patterns like lines of magnetic force around a bar magnet; radial patterns, such as stars or snow-flakes and ice-crystals; and lastly, maze, mosaic or labyrinth patterns. Almost all the patterns obtained could be classified into one of these groups. Notable features were their geometricity and their frequent movement, which was of many types—linear, oscillations, rotations, etc.

The forms of the patterns were much changed by the state of light- or dark-adaptation of the retina. In the dark-adapted state linear patterns showing a four-fold radial symmetry were prominent and the light-adapted state was marked by an increase in the complexity and geometricity of the patterns, particularly of mosaics.

A particular progression of patterns with minor variations was very consistent for each individual on many observations made over many months over quite a wide range of parameters. A progression common to many subjects (following 30-sec. dark adaptation) is an initial stationary pattern of straight lines (that is, grid, radial lines, checker-board) giving way to a rotating pattern of curved lines (concentric circles, vortex, etc.) in about 10 sec.

Certain of the patterns are particularly interesting. On shutting one eye, some subjects consistently see a series of 50–200 very clear-cut thin vertical black lines filling the whole field of vision. Other subjects see not a trace of these lines. Another interesting point is the four-fold radial symmetry seen in so many of the complex initial patterns. We have also encountered in many of our subjects a curious species of pattern obtainable only with one eye open. After about 5–20 sec. exposure to the flickering light, a pattern develops very different from the geometrical flickering patterns often in rapid jerky movement described above. These other patterns do not flicker at all. They nearly always develop in the nasal field and then sweep across almost, but never quite, to the extreme temporal field. They are usually in two colours, most often green and lilac, in a continuous and very characteristic slow oily swirling movement, described as being like the movement of oil on water, or of thick swirling oil, or boiling mud. This effect was also noted by Brown and Gebhard[4]. At other times the appearance is of a very clear and detailed stationary pattern over which very clear water is

rippling gently. They alternate with the ordinary geometrical flickering patterns, usually about every five seconds, in a manner very like retinal rivalry. It is possible that these phenomena may be produced by activity induced in the cortical neurones belonging to the closed eye by the unusual activity in the activated neurones of the open eye. Other subjects report yet a different effect—fully formed scenes of ordinary places and events. Symbolical figures such as letters and numbers are, however, never seen.

At dimmer intensities of illumination the patterns become simpler and fainter, as might be expected, and they also show some qualitative changes. There are also well-marked qualitative changes at different frequencies, the texture of the patterns tending to be finer at high frequencies and coarser at low frequencies.

The patterns follow eye-movements and are affected by the state of accommodation of the eye. The effects obtained with single eyes are rather different from those obtained with both eyes. Some of the patterns may be very similar, but quite new effects may be observed (for example, the oily swirling patterns described above); or patterns frequently obtained with both eyes may not occur, or may do so much less often, or much more faintly. A further point of interest is that, in some subjects, very clear-cut and brilliantly coloured geometrical after-images may be obtained, quite different in most cases from the previous 'open-eye' images. The after-images obtained with single eyes were usually different from those obtained with both eyes. This strongly suggests that these after-images are of cortical origin, for retinal after-images should not show radical differences if obtained with one eye and two eyes.

(2) *Explanatory hypotheses.* We have also conducted experiments to test one of three hypotheses that have been put forward to explain these phenomena. Grey Walter's original hypothesis was that they represent interference phenomena produced in a scanning mechanism attempting to deal with an intermittent signal. We have conducted two series of experiments that bear on this hypothesis. In one the frequency of stimulation was suddenly halved or doubled. This usually caused the patterns to change in the manner expected if Grey Walter's hypothesis is correct; that is, the individual elements making up the patterns became larger and coarser on halving the frequency and finer and smaller on doubling it. In the other experiments a random flicker was obtained by driving the stroboscope from a Geiger counter. In this case patterns similar to those produced by the regular flicker were obtained —particularly in one case, where the vertical line patterns were marked, these were obtained using the random flicker and looking very much like the lines seen using the regular flicker—which is somewhat unexpected under a scanning hypothesis.

Barlow's[8] hypothesis is as follows. He points out that "the flickering field evokes very vigorous activity in the visual pathways, but the stimulus is almost totally unfamiliar to the subject. In communicating his sensations the subject has to refer to causes of his sensations which are ordinary and familiar, since these are what his vocabulary is adapted to. The prevalence of moving lines and contours in the subject's descriptions might be explained along these lines, since these are the commonly occurring, simple stimuli which will cause vigorous and sustained activity in the 'on' and 'off' units of the retina, but it must be admitted that there are other, specific features of the descriptions which are not accounted for". For example, why should the patterns obtained with two eyes open be different from the patterns obtained with each eye used separately when the patterns obtained with the right eye singly are in general very similar to those obtained with the left eye singly? Thus we can argue that those elements found using binocular stimulation and not found using uniocular stimulation are probably due to cortical mechanisms.

The third hypothesis, due to Donaldson[9], is that these patterns represent the formation of corresponding domains among retinal or cortical neurones along the lines suggested by Cragg and Temperley[10]. Barlow[8] notes that the lateral inhibition in the retina makes it likely that the conditions are right for domain formation, and the differential spread of inhibition and excitation around neurones may lead to complex pattern formation. This hypothesis certainly avoids certain difficulties encountered by the other hypotheses, but there is as yet no positive evidence in its favour. Possibly a combination of the second and third hypotheses may prove to be correct. However, none of these hypotheses explains why these particular rather clear-cut geometrical patterns are obtained rather than others; for it is possible to give examples of classes of patterns that have never yet been obtained (for example, patterns in three-fold symmetry and patterns in which straight and curved lines form connected elements of the pattern).

One of the main difficulties in contemporary neurophysiology is to find out how large populations of neurones interact in perception and other functions in the intact and unpoisoned cortex. The microelectrode can only record from a very few neurones; and the electro-encephalograph, even with the multiple electrodes, will only record summated activity of vast populations of neurones. It is possible that the stroboscopic patterns, with their many constant and consistent features, and their complexity and geometrical nature, and their consistent response to the change of a number of parameters, can serve as a basis of deductions about the necessary features of the visual mechanisms responsible for them. They would also appear to offer a number of end points that could be used as a basis of psychophysical experiments, and the individual features of the patterns could correlate with personality tests or electro-encephalograph patterns.

I am most grateful to H. B. Barlow, P. E. K. Donaldson, R. L. Gregory, G. C. Grindley and Prof. O. L. Zangwill for their interest, help and advice in these investigations.

[1] Helmholtz, H. von, "Physiological Optics", **2**, 256, 303 (Optical Society of America, 1925).
[2] Edridge-Green, F. W., "The Physiology of Vision" (Bell, London, 1920).
[3] Adrian, E. D., and Matthews, B. M. C., *Brain*, **57**, 355 (1934).
[4] Brown, C. R., and Gebhard, J. W., *J. Exp. Psychol.*, **38**, 188 (1948).
[5] Walter, W. Grey, in "Perspectives in Neuro-Psychiatry", edited by D. Richter (Blackwell Scientific Publications, London, 1950).
[6] Massucco, C. A., *Arch. Psicol. Neur. Psich.*, **14**, 632 (1953).
[7] Blum, R. H., *J. Ment. Sci.*, **102**, 160 (1956).
[8] Barlow, H. B., personal communication (1956).
[9] Donaldson, P. E. K., personal communication (1956).
[10] Cragg, B. G., and Temperley, H. N. V., *E.E.G. Clin. Neurophysiol.*, **6**, 85 (1954).
See also, Purkinje's account in "Beobactungen und Versuche zur Physiologie der Sinne". Beiträge zur Kenntnis des Sehens in Subjectiver Hinsicht. Bd. 1. (Prag, 1823.) This is the first brief account of the effect.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

'Electro-Chemical' Orientation of Bracken Spermatozoids

THE chemotaxis of bracken spermatozoids, first demonstrated by Pfeffer[1], has so far been investigated by introducing a concentrated source of a stimulating substance into a suspension of spermatozoids and observing their behaviour in the resultant chemical gradient. In Pfeffer's original method, a fine glass capillary containing a solution of sodium L-malate provided the source; in these conditions spermatozoids aggregate around the tip (Fig. 1). Such experiments have revealed the highly directional character of the response[2], its chemical specificity (salts of L-malic acid and a few closely related dicarboxylic acids are active)[3], and that the response depends on the ratio between the applied and background concentrations in the suspension[1]. To permit more quantitative study of bracken sperm chemotaxis, a search has been made for conditions experimentally more favourable than those obtained with the classical methods of establishing chemical gradients. Two new phenomena, closely related to 'classical' chemotaxis, have been observed.

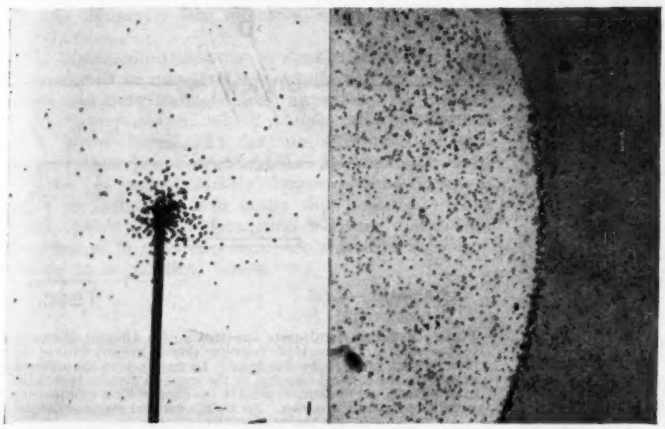


Fig. 1. Aggregation of spermatozoids at the tip of a capillary containing sodium L-malate. (× 34)

Fig. 2. Aggregation of spermatozoids at border between buffered region (darkened by indicator) and acidified region. (× 22)

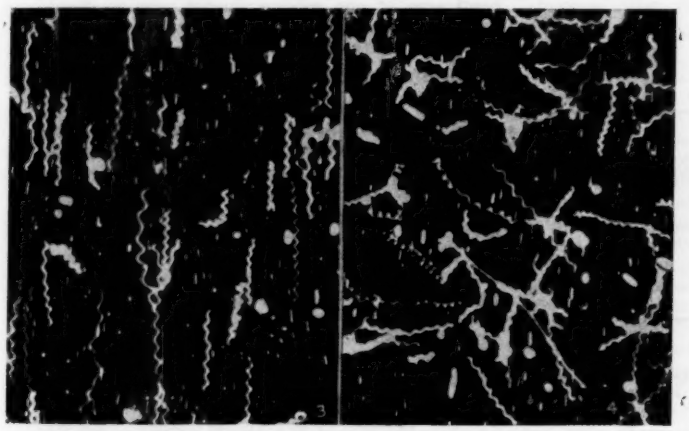


Fig. 3. Spermatozoids swimming to anode (at top) in electric field, in presence of 10^{-4} *M* sodium maleate. Projection of helical paths recorded during 3-sec. exposure. (× 50)

Fig. 4. With 10^{-4} *M* sodium fumarate and same electric field, no orientation. (× 50)

(1) When a small drop of 0·1 *M* hydrochloric acid is placed in contact with a sperm suspension containing 10^{-4} *M* sodium L-malate in 0·005 *M* *tris*(hydroxymethyl) amino methane–hydrochloric acid buffer, *p*H 8·1, actively swimming spermatozoids aggregate in a band in the region of sharp *p*H change. The result of such an experiment, with an indicator added to locate the region of sharp *p*H change, is shown in Fig. 2. No such aggregation is observed unless sodium-L-malate is present. Similar results have been obtained with the sperm suspension buffered at various *p*H's, down to 0·01 *M* sodium citrate buffer at *p*H 5·7.

(2) If an electric field of 7 volts/cm. is established within a suspension of bracken spermatozoids when the suspending medium contains 10^{-4} *M* sodium L-malate or 10^{-4} *M* sodium maleate in *tris* buffer (0·005 *M*, *p*H 8·1), the spermatozoids turn and swim directly towards the anode (Fig. 3). No reaction is observed if the concentration of sodium L-malate is less than 10^{-6} *M*; nor if 10^{-4} *M* sodium succinate is substituted for malate; nor if 10^{-4} *M* sodium fumarate is substituted for its isomer, sodium maleate (Fig. 4). The chemical specificity of the 'electro-chemical' reaction is, therefore, identical with that observed when classical methods of establishing chemical gradients are used.

As might be predicted from this experiment, the chemotaxis of bracken spermatozoids in a chemical gradient can be inhibited by application of the appropriate electric field. No differences in the morphology of the rapid and precise orienting responses occurring in these various situations have been detected, either by photographic path records of the type shown in Figs. 3 and 4, or by direct observations at higher magnification.

Further details of these experiments will be published in due course.

I am indebted to Sir James Gray for allowing me to work in his Department, and to Lord Rothschild for suggesting an investigation of this problem.

C. J. BROKAW*

Department of Zoology,
University of Cambridge.

* National Science Foundation Fellow.

[1] Pfeffer, W., *Unter. Bot. Inst. Tübingen*, **1**, 363 (1884).
[2] Rothschild, Lord, *Internat. Rev. Cytology*, **1**, 257 (1952).
[3] Rothschild, Lord, "Fertilization" (Methuen and Co., 1956).

Evidence for Subcortical Regulation of the Afferent Discharge to the Somatic Sensory Cortex in Man

Previous experiments[1,2] have shown that, in curarized cats, electrical stimulation of certain central structures (for example, the brain stem reticular formation) depresses a postsynaptic evoked response in various primary sensory relays. On the other hand, barbiturate anæsthesia or certain central lesions (involving, for example, the reticular formation) may enhance these afferent responses. These results were interpreted as a manifestation of descending inhibitory influences capable of preventing afferent signals from the sense organs from reaching the cerebral cortex. A possible clue to the physiological significance of this mechanism is provided by the interesting observation[2] that in unrestrained animals a postsynaptic auditory response in the cochlear nucleus can be blocked by turning the animal's attention toward visual or olfactory stimuli. In a similar way, a postsynaptic visual response could be depressed by turning the animal's attention toward auditory stimuli.

The present investigation was undertaken in order to determine whether in man also there is evidence of such regulating mechanisms acting upon the transmission in specific afferent pathways (cf. ref. 3). In the course of neurosurgical operations, surface and needle recording electrodes were placed in the hand area of the somatic sensory cortex. The needle electrodes, insulated except for the tip, were inserted in the cortex to a depth of about 5 mm. in order to reach the underlying white substance. The afferent discharges to the cortex and the cortical response evoked by various kinds of stimuli applied to the contralateral hand were recorded with a Grass electroencephalograph supplemented with a loudspeaker.

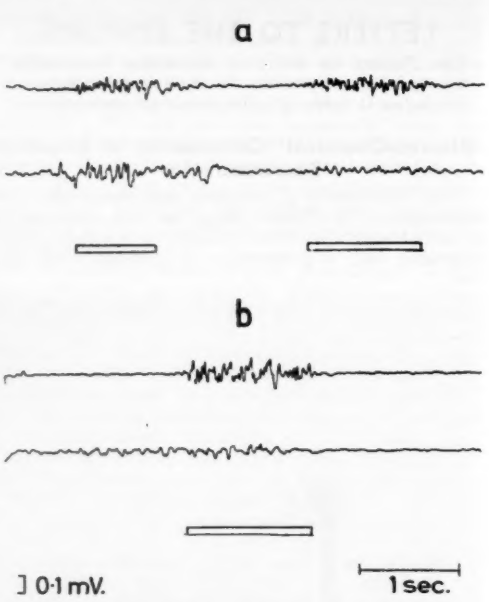


Fig. 2. Moderate barbiturate anæsthesia. (*a*) Afferent discharge (upper record) and cortical response (lower record) evoked by intermittent pressure to the hand. In contrast to the afferent discharge, the cortical response to the second stimulus is reduced in amplitude. (*b*) Pressure applied to the hand while a spontaneous spindle occurs in the cortex. No visible cortical response despite the heavy afferent discharge

Some of the main results are shown in Figs. 1 and 2. These records were obtained from the right sensory hand area of one subject during various depths of barbiturate anæsthesia. The first record (Fig. 1,*a*) was taken when the patient was under moderate anæsthesia. The surface electroencephalograph record was relatively flat with bursts of spontaneous barbiturate spindles. Moderate pressure on the palm of the left hand evoked an outburst of fast activity from the needle electrode in the white matter, while the surface record showed a series of potential fluctuations somewhat resembling the spontaneous spindles. One hour later, the anæsthesia had become quite superficial, and the cortical activity was more continuous. Similar pressure on the palm now caused no distinct outburst of fast activity or any visible change in the cortical activity (Fig. 1,*b*). The patient was then given a further dose of pentothal. This caused a marked flattening of the electroencephalograph surface record (Fig. 1,*c*). Pressure on the palm now evoked a heavy discharge from the needle electrode. At this level of anæsthesia the cortical response was relatively weak.

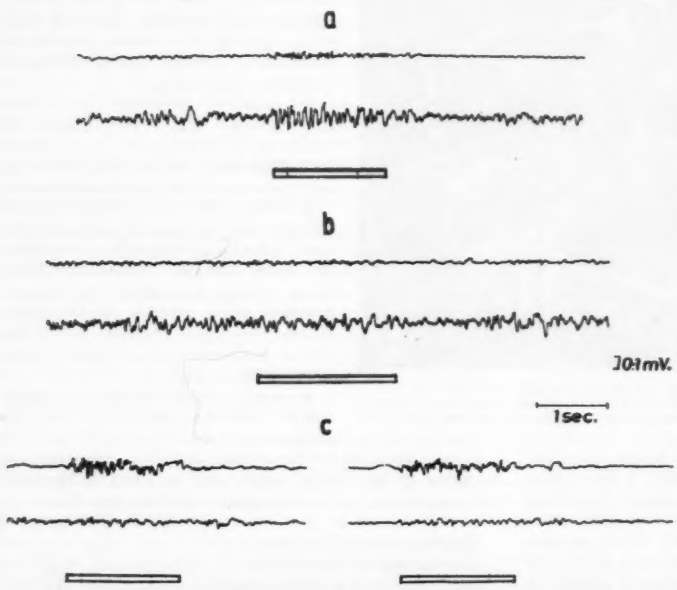


Fig. 1. Afferent discharge to the cortex (upper record) and the cortical response (lower record) evoked by pressure to the contralateral hand during (*a*) moderate, (*b*) superficial and (*c*) fairly deep barbiturate anæsthesia (see text). Time constant 0·05 sec.

It seems fairly certain that the fast activity recorded from the needle electrode represents the evoked

afferent discharge to the cortex. That it is not derived from cortical neurones may be deduced from the fact that it was increased at a level of anæsthesia that caused depression of the cortical response. Compared to the afferent discharge, the cortical response bears a much less direct relation to the sensory stimulus. It does not follow repetitive stimulation equally well (Fig. 2,*a*), and when a spontaneous spindle has just occurred, the cortical response may be impossible to identify (Fig. 2,*b*).

Stimuli that were most effective in evoking an afferent discharge to the cortex proved to be pressure, touch and passive movements of the fingers. Pinching was definitely less effective, even when it was quite hard.

The observation that the evoked afferent discharge to the cortex in man can be enhanced by barbiturate anæsthesia may indicate that anæsthesia suppresses an inhibitory action which checks afferent signals at a lower level. So far, no afferent discharge to the cortex has been identified in unanæsthetized subjects. It is not unlikely, however, that improvements in technique will make this possible. That would enable one to determine whether distraction of attention in man can influence the afferent transmission at subcortical levels.

K.-E. Hagbarth
S. Höjeberg

Neurosurgical Clinic and
Department of Clinical Neurophysiology,
Serafimerlasarettet, Stockholm K.
Nov. 30.

[1] Hagbarth, K.-E., and Kerr, D. I. B., *J. Neurophysiol.*, **17**, 295 (1954).
[2] Hernández-Peón, R., *Acta Neurol. Latinoamer.*, **1**, 256 (1955).
[3] Adrian, E. D., in "Brain Mechanisms and Consciousness", edit. by Lord Adrian, Bremer, F., and Jasper, H. H., 238 (Blackwell Sci. Pub., Oxford, 1954).

Effect of Temperature on the Degeneration of Nerve Fibres

In 1950 Armstrong[1] found that the period after injury during which a nerve fibre preserves a normal histological appearance may be surprisingly long in a poikilothermic animal kept at room temperature (*15°–20° C.*), *but that the rate of degeneration is increased* and the time after which the fibre eventually disappears is shortened by a comparatively small rise in temperature. This temperature effect is important, since one of the commonest methods for investigating *pathways and connexions in the nervous system* involves the interpretation of degenerative changes which follow experimental injury, and it is essential to know how long one must wait before it is possible to say that surviving nerve fibres, normal in *appearance, cannot have been affected by the* injury.

Experiments have been carried out on the lateral popliteal nerve of a poikilothermic animal (*Lacerta viridis*) to investigate the temperature effect in greater detail. The nerve was cut and the animals kept in three groups in cages in which the air temperature was maintained within a few degrees of 13° C., 20° C. and 35° C., respectively. Cloacal temperatures in the animals, measured with a thermocouple, were always found to approximate very closely to the air temperature.

In animals kept at 13° C., no changes in the myelin sheaths of fibres could be observed up to three weeks after section of the nerve, although by that time about half the axons present showed irregularity of calibre, vacuolation and, in the case of a few, fragmentation. It is important to emphasize, however, that about half the axons present still preserved a normal appearance in silver preparations (Bodian's method), although there was no doubt they had been cut from their cells of origin.

The condition found in cut nerves kept for twenty-one days at 13° C. is found after three days at 20° C. The majority of the fibres are still normal in appearance (both sheaths and axons) but a proportion show early degenerative changes. Even after twenty-one days at 20° C., a few fibres can be found in which both axon and sheath present a normal appearance. One would be tempted to conclude that the nerve must contain fibres which had not been cut; but this conclusion would almost certainly be wrong, since in animals kept at 35° C., with one exception, no normal fibres could be found five days or more after section of the nerve. The exception was an animal in which one apparently intact axon was found after seven days. In these animals (kept at 35° C.) not only were the histological signs of degeneration both in the sheaths and the axons virtually uniform in all fibres by about the fifth day, but also by the tenth day the removal of degenerated myelin was in an advanced stage, and practically complete by twenty-one days.

It may be concluded that for reliable interpretation, experiments on poikilothermic animals which involve the degeneration of nerve fibres should be carried out at temperatures which approximate to the body temperature of homoiothermic mammals. At ordinary room temperature in Britain, some nerve fibres may retain a normal histological appearance for three weeks and probably considerably longer after they have been cut. The question why a proportion of the fibres only should be resistant to change is an *interesting one; the calibre of the fibre does not* seem to be relevant, since both coarse and fine fibres may show this characteristic; but our experiments throw no further light on the problem. It must be noted also that the experiments are relevant *only to the peripheral nervous system.* Armstrong's[2] work suggests that in the central nervous system injured fibres may preserve a normal appearance for even longer periods, and this is a matter which requires further investigation.

Finally, it may be added that in a parallel series of experiments in which the nerve was crushed but not cut, evidence was obtained that at higher temperatures the rate of regeneration was accelerated to about the same extent as the rate of degeneration. The effect of temperature on regeneration has been studied in detail by Lubinska and Olekiewicz[3] in amphibians using physiological methods to estimate the rate of fibre growth. Our own experiments, using histological methods, are in accord with theirs.

H. J. Gamble
F. Goldby
G. M. R. Smith

Department of Anatomy,
St. Mary's Hospital Medical School.
Dec. 20.

[1] Armstrong, J. A., *J. Anat., Lond.*, **84**, 146 (1950).
[2] Armstrong, J. A., *J. Anat., Lond.*, **85**, 277 (1951).
[3] Lubinska, L., and Olekiewicz, M., *Acta Biol. Exp., Varsovie*, **15**, 125 (1950).

Swelling of Fibrous Proteins

Measurements of the energies and amounts of sorption of water vapour by wool keratin, when compared with those on silk fibroin[1], have led us to generalizations concerning the nature of swelling of protein fibres. The heats of wetting of keratin containing adsorbed and desorbed water (no hysteresis was observed) were combined with the water vapour adsorption isotherm to calculate the thermodynamic properties[2]. The differential properties are given in Fig. 1. Also, the analogous properties of the silk fibroin–water vapour system are included (inset *A*) because their full significance was not appreciated until now.

Adsorption area measurements assist in interpreting protein–water interactions. It has been shown[3,4] that the Brunauer, Emmett and Teller and the Harkins–Jura equations can be applied to the lower and upper parts, respectively, of the adsorption isotherm. Their applications to keratin, fibroin and cellulose[5] are given in Table 1.

We believe that the thermodynamic properties are the net result of adsorption and swelling phenomena. The radial swelling of keratin[6] is included in Fig. 1 (inset *B*) for comparison.

The $\overline{\Delta H}$ values suggest hydrogen bonding. These are net values above the heat of condensation to liquid water. If the energy of a single hydrogen bond in liquid water is about 4·5 kcal., the H-bond energies at zero regain are 9·3 for keratin and 6·8 for fibroin on the assumption that each water molecule makes *two* bonds. After a very rapid decrease, $-\overline{\Delta H}$ levels off to about the same value for both proteins, namely, 2·4 kcal. This means a H-bond energy of 6·9 on the assumption that each water molecule makes *one* bond. It is suggested that the rapid initial decrease in $-\overline{\Delta H}$ is partly caused by the energy required to disorganize or 'peptize' the dried gel[7]. The levelling-off in $\overline{\Delta H}$ coincides with the Brunauer–Emmett–Teller adsorption-range. Probably in this range the initial monolayer is completed by water molecules adsorbing largely without restraints other than those directed to the surface to form single hydrogen bonds.

At low regains, the $\overline{\Delta S}$ curves indicate a high degree of ordering, arising from the chemisorption of water molecules between the polypeptide chains. At the same time, a large disordering of the protein gel occurs, reflected in a rapid decrease in $-\overline{\Delta S}$ (and $-\overline{\Delta H}$). After a large part of this disorganization has occurred, $-\overline{\Delta S}$ reaches a minimum and then rises to a maximum. Here it is suggested that ordering due to adsorption in the first layer is greater than disordering due to swelling. After completion of the first layer, and the second layer begins to build up above it[4], the degree of ordering falls off both because of adsorption and some further swelling.

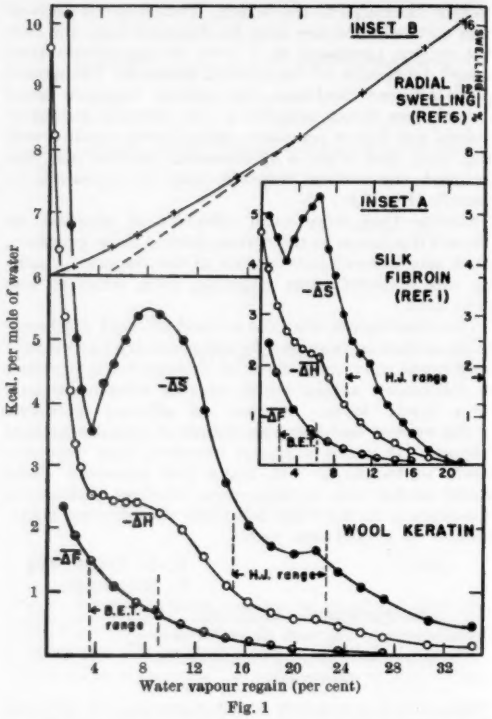


Fig. 1

The next characteristic break in the $\overline{\Delta S}$ curve occurs after the onset of the Harkins–Jura range. The Harkins–Jura equation is considered to apply to condensed films the onset of which should involve a *decrease* in $-\overline{\Delta S}$. However, the rate of swelling also changes at this point (20 per cent regain, Fig. 1, inset *B*) to a rate directly proportional to the regain. It is suggested that below 20 per cent regain, the water either is compressed by adsorption or is filling the molecular interstices (these may be concomitant processes). Above 20 per cent, the water may be causing intermicellar rather than intermolecular swelling. The change from one type of swelling to the other would be accompanied by some recovery in $-\overline{\Delta S}$.

It would appear that there are three consecutive ways in which water swells the gel, the ranges of these ways being 0–4·5, 4·5–20 and 20–100 per cent wetted keratin.

The absence of hysteresis in the heat of wetting of keratin supports Barkas's[8] explanation of the hysteresis of the sorption isotherm that it arises from the difference between the hydrostatic pressures exerted by a plastic gel during adsorption and desorption of water vapour.

Table 1

Fibre	Brunauer–Emmett–Teller			Harkins–Jura		
	Range		Monolayer (gm./100 gm.)	Range		Monolayer (gm./100 gm.)
	Relative pressure	Regain (per cent)		Relative pressure	Regain (per cent)	
Keratin	0·08–0·35	3·5–9·1	7·0	0·62–0·90	14·4–22·3	7·7
Fibroin	0·06–0·37	2·2–6·2	4·8	0·60–1·0	9·2–36	4·8
Cellulose	0·12–0·36	2·1–4·1	3·1	0·60–1·0	6·2–23	3·1

The observations given in Table 1 also may provide some evidence to account for the well-known lack of wettability of keratin compared with fibroin and cellulose. The Harkins–Jura range of keratin cuts off at a relative pressure of 0·90. Moreover, the monolayer content of the upper part of the keratin isotherm is about 10 per cent higher than that of the lower part. These differences suggest that water vapour forms clusters[9] on the wool surface at high regains whereas it forms a continuous film on silk and cellulose.

We believe that the above adsorption and swelling properties are general for all solid proteins and other gels in Nature such as cellulose. Measurements of the latter are in progress. It should be pointed out that Wahba[5] found a maximum in the differential entropy curve of cellulose; but he did not find a minimum at lower regains.

A full report of the present results on keratin is being given elsewhere. We wish to acknowledge helpful discussions with Dr. H. W. Habgood, the assistance of D. E. Thyne in constructing the calorimeter and financial assistance from the National Research Council of Canada.

JOHN L. MORRISON
JAMES F. HANLAN

Department of Chemistry,
University of Alberta,
Edmonton, Alberta.
Dec. 4.

[1] Dunford, H. B., and Morrison, John L., *Canad. J. Chem.*, **33**, 904 (1955).
[2] Dole, M., and McLaren, A. D., *J. Amer. Chem. Soc.*, **69**, 651 (1947).
[3] Bull, H. B., *J. Amer. Chem. Soc.*, **66**, 1499 (1944).
[4] Dunford, H. B., and Morrison, John L., *Canad. J. Chem.*, **32**, 558 (1954).
[5] Wahba, M., *J. Phys. and Coll. Chem.*, **54**, 1148 (1950).
[6] "Wool Research 1918–1954", **2**, "Physical Properties", 12 (Wool Industries Res. Assoc., Leeds).
[7] Cassie, A. B. D., *Trans. Farad. Soc.*, **41**, 458 (1945).
[8] Barkas, W. W., *Trans. Farad. Soc.*, **38**, 194 (1942).
[9] Cassie, A. B. D., Proc. Soc. Dyers and Col., "Fibrous Proteins", 86 (May 1946).

Revealing of Surface Texture by Metal Deposition

ZINC and cadmium atoms are known to exhibit good mobility over, and ready re-evaporability from, a suitable substrate surface on which the metal vapour beam is incident. Thus the vapour – beam flux density must exceed a certain minimum value if a deposit is to be formed. This critical flux density depends on the nature of the substrate[1–3] and should therefore vary from place to place on the always more or less imperfect surface of a crystal. Provided the corresponding changes in the critical flux density are sufficiently large, it should thus be possible to make visible such imperfections.

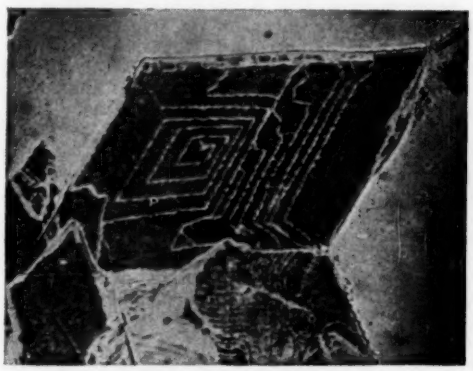


Fig. 1. Transmission micrograph. (× 750)

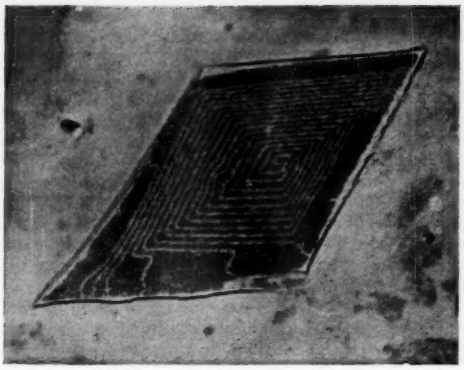


Fig. 2. Transmission micrograph. (× 750)

To test these conclusions, zinc vapour was condensed *in vacuo* on the basal planes of stearic acid crystals, the vapour flux density being held slightly above the critical. It was found that the smooth surfaces between the well-known growth spiral steps became heavily metallized, while the actual spiral step edges and the regions in their immediate neighbourhood remained virtually free of metal. As a result the growth-spirals starting from screw dislocations were strikingly revealed.

Typical results are shown in Figs. 1 and 2.

V. R. GURU MOORTI
M. K. GHARPUREY

National Chemical Laboratory,
Poona 8, India.
Dec. 10.

[1] Estermann, J., *Z. Phys.*, **33**, 340 (1925).
[2] Cockcroft, J. D., *Proc. Roy. Soc.*, A, **119**, 293 (1928).
[3] Déo, A. R., and Gharpurey, M. K., *J. Sci. Indust. Res., India* (in the press).

Variation in the Lignin laid down by *Eucalyptus regnans* at Different Stages of Growth

THE spectrum of softwood lignin shows an absorption maximum at about 280 mμ[1]; this is at the same position for various lignin preparations and for calcium lignosulphonates[2]. Hardwood lignin shows an absorption peak at 275 mμ[1], which is the same as that shown by lignin extracted from the wood of a ten-year old specimen of *Eucalyptus regnans* with methanol at 150° C.[3]. We have recently observed that the absorption maximum for lignin prepared by the same method from extractive-free wood from the outer growth rings of heartwood of trees 30–100 years old was at an even shorter wavelength, usually below 270 mμ. The spectra of lignins from tension wood from immature trees of *E. regnans* and *E. goniocalyx* also showed maxima in the range 267–272 mμ.

These observations led to an investigation of the variation in the lignin spectrum with the

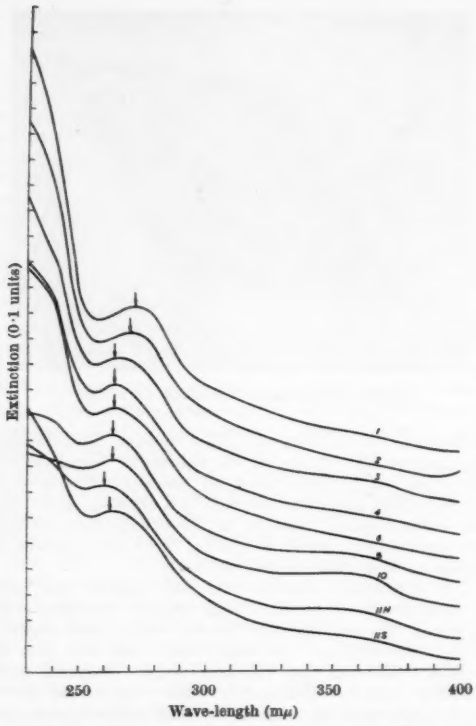


Fig. 1. Spectra of lignins from a radial section of *E. regnans*. Specimens numbered from centre of tree outwards. No. 11 subdivided into heartwood, *H*, and sapwood, *S*

radial position in the tree. Eleven specimens were taken from the pith to the sapwood from a butt log of *E. regnans* which was 46 in. in diameter and showed 90 growth-rings. These specimens were ground and extracted with methanol for 8 hr. and again for 16 hr. at 150° C. By this procedure about a third of the lignin was extracted from all specimens. The extracts were concentrated, a spot of each placed on a borate paper chromatogram which was then developed with *iso*butanol/benzene/water (1 : 9 : 10). The tan-coloured spots at $R_F = 0$ were cut out, the lignins eluted with methanol and their absorption spectra determined; the results for the 8-hr. extracts are shown in Fig. 1. Readings were taken at 2-mμ intervals between 250 and 280 mμ. These spectra have been adjusted so that the extinction at each absorption maximum is 0·622; they have been drawn at extinction intervals of 0·100 between the maximum values to facilitate comparison. The spectra vary systematically from the centre of the tree, specimen 1, outwards to specimen 10. The main points of variation are: (*a*) the shift of the maximum from 272 mμ in the centre specimen to 262 mμ in the outer specimens; (*b*) decrease in the absorption at 230 mμ relative to the maximum in the 262–272 mμ range; (*c*) a shallower minimum in the 250–260 mμ range; (*d*) appearance of a weak band at about 350 mμ. The 16-hr. extracts gave similar results. Specimen 11 does not conform entirely to the general pattern, but the maxima of heartwood and sapwood portions are at 260 mμ and 262 mμ respectively. It is improbable that the differences result from the presence of impurities as the spectra are similar over most of the range and the peak at 272–262 mμ is merely shifted. A very large relative amount of material other than lignin would be required to mask completely the band at 272 mμ and bring about such a large reduction in absorption at 230 mμ. The generally flatter curve of the lignin from the outer heartwood of mature trees suggests a greater diversity of bond types and the band at 350 mμ is probably associated with free side-chains of the coniferaldehyde type[1,5]. It appears from the examination of this tree that the lignin laid down in the young tree is not transformed to the type found in the outer heartwood of mature trees. Thus the distinction between the two types of lignin is not connected with the sapwood–heartwood transformation. Further investigations of tension-wood lignin and of the spectra of methanol lignin fractions are being carried out, and a full account will be published elsewhere.

David E. Bland
B. Hirnyj

Division of Forest Products,
Commonwealth Scientific and
Industrial Research Organization,
South Melbourne, S.C.4.
Dec. 11.

[1] Brauns, F. E., "Chemistry of Lignin" (Academic Press, Inc., New York, 1952).
[2] Aulin-Erdtman, G., *Svensk Papperstidning*, **57**, 745 (1954).
[3] Bland, D. E., and Gatley, F. M., *Nature*, **173**, 32 (1954).
[4] Smith, D. C. C., *Nature*, **176**, 927 (1955).
[5] Aulin-Erdtman, G., *Svensk Papperstidning*, **56**, 91 (1953).

Grass Pollen Constituents: the Meso-inositol Content

Inositol has been shown by means of paper chromatography to be present in grass pollen[1]. Using a microbiological assay method involving the yeast *Kloeckera brevis*[2], the concentrations present in six grass pollens have been determined. The values obtained in some species (dried over silica gel) are shown in Table 1. A substantial proportion of the total inositol is found in the free state.

Table 1

	Free (mgm./gm.)	Total (mgm./gm.)
Dactylis glomerata (cocksfoot)	38·4	38·8
Lolium multiflorum (Italian rye grass)	35·6	43·1
Alopecurus pratensis (meadow foxtail)	35·9	46·2
Anthoxanthum odoratum (sweet vernal)	30·1	35·8
Arrhenatherum elatius (tall oat)	41·6	44·8
Zea mais (maize)	32·5	38·9

Aqueous extraction of the pollen resulted in more than 80 per cent elution of the free inositol within 1 min. at room temperature; this rate of extraction was found to be of the same order as that for the extraction of carbohydrates, glycosides and some of the allergens associated with grass pollens.

Corn pollen was shown by Miyake[3] to contain inositol; Anderson and Kulp[4] estimated that in this species 1 per cent of the moist weight of pollen could be accounted for by free inositol.

The concentration of inositol present in grass pollens appears to exceed that found in other plant tissues, the highest value recorded in the literature, 16 mgm./gm. dry tissue, being found in orange[5]. The reproductive tissues in the animal kingdom are also associated with high concentrations; for example, Mann[6] obtained a mean value of 2–3 gm./100 ml., equivalent to about 130–200 mgm./gm. of dry matter for boar seminal vesical secretion. Concentrations of

inositol are higher in the tissues and fluids of fœtal and growing animals than in those of adult animals[7,8]. While it is possible that inositol, in virtue of the high concentration encountered, may play an important part in the carbohydrate metabolism of tissues concerned with rapid metabolism, it is also possible that growing tissues need stores or reserves of inositol, both in plants and in animals. The true significance of the high inositol concentrations cannot as yet be assessed.

R. Augustin
D. A. Nixon

Wright–Fleming Institute of Microbiology,
and the
Physiology Department,
St. Mary's Hospital Medical School,
London, W.2.
Dec. 19.

[1] Augustin, R., Relazioni e communicazioni, 3rd European Congr. Allergy, **1**, 411 (1956).
[2] Nixon, D. A., *J. Physiol.*, **132**, 41 (1956).
[3] Miyake, S., *Jap. J. Biochem.*, **2**, 27 (1922).
[4] Anderson, R. J., and Kulp, W. L., *J. Biol. Chem.*, **50**, 433 (1922).
[5] Chedelin, V. H., and Williams, R. J., Univ. of Texas Pub., 4237, 105 (1942).
[6] Mann, T., *Proc. Roy. Soc.*, B, **142**, 21 (1954).
[7] Starkenstein, E., *Z. physiol. Chem.*, **58**, 162 (1909).
[8] Campling, J. D., and Nixon, D. A., *J. Physiol.*, **126**, 71 (1954).

Occurrence of Shikimic Acid in Gooseberry Fruits

In a recent survey of the organic acids of fruits, shikimic acid has been found in considerable amount in each of the varieties of gooseberry examined. Aqueous extracts of unripe fruits of the varieties Leveller, Careless and Whinham's Industry, after precipitation of pectin with 60 per cent acetone, were investigated by paper chromatography using the following three solvents: (1) benzyl alcohol – *iso*-propyl alcohol – *tert.*-butyl alcohol – water – formic acid (**3 : 1 : 1 : 1 : 2** per cent)[1], (2) *n*-propyl alcohol – conc. ammonia (70 : 30)[2], (3) phenol – water – formic acid (3 : 1 : 1 per cent)[1]. In addition to malic and citric acid spots, a third spot (*A*) was observed with R_F values in solvents (2) and (3), 0·17 and 0·58 respectively, identical with those of shikimic acid; citric acid and shikimic acid do not separate in solvent (1). Spot *A* separated from quinic and dihydroshikimic acids in solvent (3)[3], R_F values 0·58, 0·50 and 0·66 respectively, and rapidly gave a greenish-yellow colour at room temperature on spraying with sodium metaperiodate followed by sodium nitroprusside and piperazine[4]. This reagent is so far only known to give a reaction with quinic, shikimic and dihydroshikimic acids[5]. It has now been found that shikimic acid reacts at room temperature within a few minutes, while the other acids react more slowly. This observation is an additional aid to identification.

Addition of the gooseberry pectin-free extract to a silica gel column and elution with *tert.*-butyl alcohol – chloroform mixtures of increasing *tert.*-butyl alcohol content showed an acid peak in the same position as that shown by an authentic specimen of shikimic acid. Examination of the appropriate fractions by paper chromatography also indicated the presence of shikimic acid in amounts corresponding to 0·30 per cent of the fresh weight of the fruit.

In order to isolate the suspected shikimic acid, a volume of pectin-free extract was first treated with 'Amberlite' *IR*-120 resin in the hydrogen form, and passed through a column of 'Amberlite' *IRA* 400 (acetate) resin, which was then treated with 0·1 *N* acetic acid. Acid *A* was eluted at an early stage together with a trace of quinic acid (identified by the paper chromatographic methods described above). The two acids were separated on a silica gel column; acid *A* was eluted first. 0·15 gm. was obtained from 50 gm. of berries and, after treatment with charcoal, crystallized from 95 per cent ethanol and then from glacial acetic acid with melting point 184–85°, which showed no depression on admixture with an authentic specimen of shikimic acid. Elementary analysis gave C, 48·41; H, 5·90 per cent; shikimic acid requires C, 48·27; H, 5·79 per cent. Acid *A* is therefore shown to be shikimic acid and contributed in the gooseberry 20 per cent of the total acidity on a weight basis.

In contrast to the results of Hulme[6], who observed increasing shikimic acid content of Bramley's Seedling with increasing maturity and the onset of senescence, the present results on the gooseberry variety Careless show that from the under-ripe stage to the fully ripe stage six weeks later, the weight of shikimic acid per berry remained practically constant.

The simultaneous appearance of shikimic and quinic acids in a plant tissue may be significant, although, in the bacterial mutants studied by Davis[6], quinic acid was off the main route of aromatization from carbohydrate via shikimic acid to the aromatic amino-acids. The occurrence of quinic and shikimic acids in the same plant tissue was first observed by Boldt[7], who isolated these acids from the carpels of *Illicium verum*, and later by Hulme and Richardson, who isolated them from grasses[8,9] and by Hulme from apple fruits (Bramley's Seedling)[6]. Hathway[10] has identified by paper chromatographic methods quinic and shikimic acids in myrobalans, and I have detected both acids in gooseberries, blackberries, cider apples, perry pears and quince fruits, using fractional elution from anion exchange resin columns and paper chromatography. The co-existence of these acids is probably extensive in plant tissues although their metabolic function is still unknown. L. F. Burroughs (private communication) has observed little difference in the pattern of free aromatic amino-acids of gooseberry and in soft fruits in which shikimic acid was either not detected or was found in trace amounts only. This, however, does not exclude differences in other aromatic constituents.

A detailed account of this work will be published elsewhere. I wish to thank Dr. A. Pollard, of this Station, for helpful advice and discussion.

G. C. Whiting

Research Station,
Long Ashton,
Bristol.
Dec. 15.

[1] Stark, J. B., Goodban, A. E., and Owens, H. S., *Anal. Chem.*, **23**, 413 (1951).
[2] Isherwood, F. A., and Hanes, C. S., *Biochem. J.*, **55**, 824 (1953).
[3] Phillips, J. D., Pollard, A., and Whiting, G. C., *J. Sci. Food Agric.*, **7**, 31 (1956).
[4] Cartwright, R. A., and Roberts, E. A. H., *Chem. and Indust.*, 230 (1955).
[5] Hulme, A. C., *Nature*, **178**, 991 (1956).
[6] Davis, B. D., "A Symposium on Amino Acid Metabolism", edited by McElroy, W. D., and Glass, H. B., 802 (The Johns Hopkins Press, Baltimore, 1955).
[7] Boldt, A., *Pharm. Zentr.*, **78**, 157 (1937), through Br. Abstr. **A.2**, 194 (1937).
[8] Hulme, A. C., and Richardson, A., *J. Sci. Food Agric.*, **5**, 221 (1954).
[9] Richardson, A., and Hulme, A. C., *Nature*, **175**, 43 (1955).
[10] Hathway, D. E., *Biochem. J.*, **63**, 380 (1956).

Decrease of Phosphorus/Oxygen Ratios by Dinitrophenol *in vivo*

In a paper by one of us[1], it was reported that intraperitoneal administration of 2 : 4-dinitrophenol produces a high degree of uncoupling of oxidative phosphorylation in mitochondria from several rat tissues. There were histological changes in these tissues, which showed mitochondrial swelling and cloudy swelling. In the case of the liver, we have found that very shortly after treatment, fat droplets appear in the cells, followed later by glycogen. Similar changes were observed by Fonnesu and Severi[2,3], who found also that cloudy swelling is characterized by decrease of phosphorus/oxygen ratios. In addition, treated rats showed increase of body temperature, a condition which has been referred by many authors to the decline of phosphorylation[4,5].

In a recent communication in *Nature*, Parker[6] could not confirm the inhibition by 2 : 4-dinitrophenol of oxidative phosphorylation *in vivo*. His work, however, differs from ours in two important ways: (1) the nature of the substrate used, which was α-ketoglutarate in our experiments, glutamate in those of Parker; (2) the amount of mitochondria used for each determination, which corresponded to 100 mgm. liver in our experiments, and to 250 mgm. in Parker's. With regard to point (1), Saktor and Cochran[7] have found that the phosphorylation coupled with the oxidation of ketoglutarate by housefly muscle mitochondria is more sensitive to 2 : 4-dinitrophenol than that coupled with the oxidation of glutamate. With regard to point (2), one may observe that the mitochondrial membrane is the limiting factor in many enzymic reactions, and that the use of too large amounts of mitochondria may then be the cause of unexpected results.

In order to check the influence of these differences in the methods, the experiments have been repeated, using different amounts of mitochondria (corresponding to 100 and 250 mgm. of wet liver, respectively), and two substrates (ketoglutarate and glutamate). Since Hunter and Ford[8] have shown that loss of oxidative phosphorylation occurring after mitochondrial swelling *in vitro* can be partially restored by addition of diphosphopyridine nucleotide, 1×10^{-3} *M* diphosphopyridine nucleotide was added in each Warburg flask. The suspension medium for the preparation of the homogenate was 0·25 *M* sucrose containing 0·002 *M tris* buffer, *p*H 7·6. The other experimental conditions were those described in the previous paper[1].

Table 1. Uncoupling of Oxidative Phosphorylation in Rat Liver Mitochondria after Treatment with 2 : 4-Dinitrophenol (3 mgm./100 gm. Body-weight). Eight Experiments for Each Group. Standard Deviation is given for Each Average

Amount of mitochondria (mgm. liver)	Substrate	Treatment	μ Atoms P	μ Atoms O	P/O
250	α-Keto-glutarate	None	14·67±2·8	4·33±0·8	3·39±0·2
100	α-Keto-glutarate	None	11·52±1·6	3·37±0·4	3·41±0·2
250	Glutamate	None	11·76±2·7	4·19±0·9	2·80±0·2
100	Glutamate	None	8·47±1·9	3·29±0·7	2·57±0·3
250	α-Keto-glutarate	DNP	7·29±2·3	3·05±0·8	2·39±0·5
100	α-Keto-glutarate	DNP	2·28±1·8	1·67±0·7	1·36±0·6
250	Glutamate	DNP	6·78±1·4	3·14±0·4	2·16±0·3
100	Glutamate	DNP	3·96±2·1	2·53±0·9	1·56±0·4

It is clear from Table 1 that a decrease of phosphorus/oxygen ratios was observed again in rats receiving 3 mgm. 2 : 4-dinitrophenol/100 gm. body-weight. The extent of decrease, which was statistically significant for each treated group, was, however, higher with ketoglutarate than with glutamate, and with mitochondria corresponding to 100 mgm. liver. The values obtained with mitochondria from 250 mgm. tissue were never 2·5 times as great as those obtained with the particles from 100 mgm. tissue. Oxidation of both substrates was decreased after treatment with 2 : 4-dinitrophenol, but the decrease of phosphorylation was always higher. Both differences in the methods may, therefore, have co-operated in the production of the discrepancy between the results obtained by Parker and our results.

Mario U. Dianzani*
Maria Assunta Dianzani Mor*
Laboratorium voor Physiologische Chemie,
University, Utrecht.

* Present address: Istituto di Patologia Generale, University of Genoa.

[1] Dianzani, M. U., and Scuro, S., *Biochem. J.*, **62**, 205 (1956).
[2] Fonnesu, A., and Severi, C., *Brit. J. Exp. Path.*, **36**, 35 (1955).
[3] Fonnesu, A., and Severi, C., *J. Biophys. Biochem. Cytol.*, **2**, 293 (1956).
[4] Lardy, H. A., and Elvehjem, C. A., "Ann. Rev. Biochem.", **14**, 16 (1945).
[5] Pasquinelli, F., and Calzolari, G., *Arch. Sci. Biol.*, **37**, 507 (1953).
[6] Parker, V. H., *Nature*, **178**, 261 (1956).
[7] Saktor, B., and Cochran, D., *J. Amer. Chem. Soc.*, **78**, 3227 (1956).
[8] Hunter, F. E., and Ford, L., *J. Biol. Chem.*, **216**, 357 (1955).

The Antihæmophilic and Christmas Factor Activities of Ethanol Fractions of Brain Extract

The activity of brain tissue extract in the mechanism of blood coagulation is considered to be equivalent to a combination of platelets, antihæmophilic globulin and Christmas factor[1] (plasma thromboplastin component). The latter two blood-clotting factors have been separated in different ethanol fractions of plasma. It was thus of interest, following our report on the isolation of antihæmophilic globulin from brain tissue[2], to study the antihæmophilic and Christmas factor activities of various ethanol fractions obtained from brain extract.

Heparinized human brain extract was prepared as previously described[2]. The activity of each fraction was determined by its effect on the blood and plasma-clotting time, prothrombin consumption and thromboplastin generation test.

On treating the brain extract in a way similar to that described by Cohn *et al.*[3] in 1946, for plasma fractionation, traces of these two factors were present in the products corresponding to fractions I, II+III, IV−1 and IV−4. However, using the modified method of Cohn *et al.*[4], the two factors were present in the precipitate obtained at 0·04 *M* sodium concentration, 0·066 *M* fraction ethanol and *p*H 5·8 (corresponding to fraction I+II+III of plasma[4]). Paper electrophoresis of this precipitate using barbitone buffer, *p*H 8·6, showed two bands: one at the origin and another occupying the β-globulin position. This fraction was found to contain no heparin. The latter was precipitated with most of the remaining proteins on the addition of 0·02 *M* zinc acetate.

The following experiments were carried out with the precipitate containing the Christmas factor and antihæmophilic globulin in an endeavour to obtain each factor separately. A reagent[4] containing 0·6 *M*

glycine, 0·051 *M* fraction ethanol and 0·005 *M* sodium extracted both factors from the precipitate at *p*H 6·8, it did not extract either at *p*H 5·5 and caused marked diminution in their potencies. The extract obtained using a solution of *p*H 7·8, ionic strength 0·005 and alcohol concentration 0·07 *M* [5] contained the two factors. Attempts at isolating each factor separately by re-precipitation from the extracts at *p*H ranging from 4·0 to 5·6 were unsuccessful, and the activity of both factors in the precipitates were adversely affected.

In blood plasma, the antihæmophilic globulin has been separated together with fibrinogen in fraction I [3], while the Christmas factor potency has been demonstrated in fractions II+III and IV [6]. In brain extract, the association of these two blood-clotting factors in the same ethanol fraction may be attributed to one or both of the following causes.

(1) In the absence of fibrinogen, antihæmophilic globulin may acquire its full behaviour as β_2-globulin[7], to which group the Christmas factor belongs[8]. The two proteins precipitated together most probably form a protein–protein complex which could not be decomposed by the reagents used.

(2) The nature of the two factors in the brain tissue may be different from that present in the blood; in the case of antihæmophilic globulin, its non-migration in the electric field when examined by paper electrophoresis[2] seemed to suggest this possibility.

We wish to thank Dr. S. W. Stanbury for the use of the refrigerated centrifuge.

F. Nour-Eldin
(Research Fellow in Hæmophilia)
John F. Wilkinson
Department of Hæmatology,
Royal Infirmary, and
University of Manchester.
Dec. 14.

[1] Biggs, R., Douglas, A. S., and Macfarlane, R. G., *J. Physiol.*, **122**, 554 (1953).
[2] Nour-Eldin, F., and Wilkinson, J. F., *Brit. J. Hæmat.*, **2**, 433 (1956).
[3] Cohn, E. J., Strong, L. E., Hughes, jun., W. L., Mulford, D. J. Ashworth, J. N., Melin, M., and Taylor, H. L., *J. Amer. Chem. Soc.*, **68**, 459 (1946).
[4] Cohn, E. J., Gurd, F. R. N., Surgenor, D. M., Barnes, B. A., Brown R. K., Derouaux, G., Gillespie, J. M., Kahnt, F. W., Lever, W. F., Liu, C. H., Mittleman, R. F., Mouton, K., Schmid, K., and Uroma, E., *J. Amer. Chem. Soc.*, **72**, 465 (1950).
[5] Oncley, J. L., Melin, M., Richert, D. A., Cameron, J. W., and Gross, jun., P. M., *J. Amer. Chem. Soc.*, **71**, 541 (1949).
[6] White, S. G., Aggeler, P. M., and Emery, B. E., *Proc. Soc. Exp. Biol., N.Y.*, **83**, 69 (1953).
[7] Spaet, T. H., and Kinsell, B. G., *Proc. Soc. Exp. Biol., N.Y.*, **84**, 314 (1953).
[8] Aggeler, P. M., Spaet, T. H., and Emery, B. E., *Science*, **119**, 806 (1954).

Hyponitrite Reductase in *Neurospora*

There is much uncertainty in regard to the pathway of nitrite reduction in micro-organisms and in higher plants. Although nitrite and hydroxylamine reductases have been found in some bacteria[1], *Neurospora* and in higher plants[2,3], the immediate reduction product of nitrite has not been identified. Several workers[4] have suggested that hyponitrite is the intermediate, but Taniguchi *et al.*[1] have shown that hyponitrite was not reduced by crude extracts of a bacterium tolerant to halogens containing all the enzyme systems for the successive reduction of nitrate to ammonia. In the denitrification process, too, hyponitrite as well as nitramide have been postulated to be intermediates in nitrite reduction. Lees[5], however, found that hyponitrite was not utilized by washed cells of *Nitrosomonas*.

We have identified an enzyme in *Neurospora* which will reduce sodium hyponitrite to hydroxylamine by reduced diphosphopyridine nucleotide. The hydroxylamine was further reduced to ammonia by a specific reductase present in the extract.

Neurospora crassa wild type 5279*a* (macroconidial) was grown in a Fries medium[6] with sodium nitrate as the source of nitrogen. After four days growth in the dark at 30° C., the felts were collected in a Büchner funnel, well washed in glass-distilled water, and frozen at −17° C. for 12 hr. The felts were then ground in a mortar with four times their weight of phosphate buffer (*p*H 7·5) and then in a Ten Broeck glass macerator at 0° C. The homogenate was centrifuged at 3,000*g* for 15 min. at 4° C. The supernatant solution served as the enzyme source. Protein was determined in the extracts by the Folin method.

Sodium hyponitrite was prepared by allowing 5 gm. of hydroxylamine sulphate in 12 ml. distilled water to react with 2 gm. of sodium nitrite in 8 ml. distilled water at 0° C. 5 ml. of 0·5 *N* silver nitrate solution with 20 ml. of distilled water were added to the solution and the yellow precipitate of silver hyponitrite was allowed to settle out in the dark, for 15 min., before filtering it through a No. 42 Whatman paper in a Buchner funnel. The precipitate, well washed with cold distilled water, was transferred to a specimen tube containing 2 ml. of saturated sodium chloride and filtered. The filtrate contained sodium hyponitrite. The antipyrene test on aliquots of the filtrate, which is specific for nitrite, was negative and hydroxylamine was not detected using a method in which ferric iron is reduced to ferrous iron, the latter determined by *o*-phenanthroline. This method is specific for hydroxylamine, detecting as little as 0·1 μgm., in the presence of hyponitrite (Nicholas, D. J. D., unpublished results). The amount of hyponitrite in solution was determined quantitatively by oxidizing the hyponitrite to nitrite with iodine as in the Czaky method and the nitrite was determined by the sulphanilamide and N-(-1-naphthyl) ethylenediamine reagents. The amount of hyponitrite present was 5/2 of the nitrite formed, calculated for the reaction:

$$5H_2N_2O_2 + O_2 \rightarrow 2HNO_2 + 4H_2O + 4N_2O$$

The results of the enzyme assays in Conway units are shown in Table 1. All reagents used (except the enzyme) were boiled to eliminate the last traces of ammonia and, after cooling rapidly, were used immediately in the assay.

Table 1. Hyponitrite Reductase in *Neurospora*

Complete system. Outer cell of Conway unit, 0·15 ml. 0·2 *M* pyrophosphate (*p*H 7·5); 0·1 ml. 4×10^{-3} *M* sodium hyponitrite; 0·05 ml. boiled pig heart; 0·2 ml. enzyme (8·3 mgm. protein/ml.); 0·1 ml. 10^{-3} *M* reduced diphosphopyridine nucleotide. Inner cell: 1·5 ml. 0·01 *N* hydrochloric acid. Incubated for 20 min. at laboratory temperature, then 1 ml. saturated potassium carbonate added to outer cell and incubated further, for 1½ hr. 0·4 ml. aliquots taken from inner cell for ammonia determination by the phenate–hypochlorite method (ref. 7)

Exp.	Ammonia produced in mμmoles/20 min./ml. enzyme			Specific activity of enzyme: mμmoles ammonia/20 min./mgm. protein
	Complete system	Omit reduced diphosphopyridine nucleotide	Omit enzyme	
1	288	48	0	34·7
2	237	49	0	28·5
3	411	51	0	28·3

The results in Table 1 show that ammonia was produced when hyponitrite was incubated with the enzyme and reduced diphosphopyridine nucleotide. In the absence of the enzyme no ammonia was produced and without the coenzyme only small amounts were detected.

The results in Table 2 show the effect of inhibitors on the enzyme.

Table 2. Effect of Inhibitors on Hyponitrite Reductase (per cent Inhibition)

0·2 ml. enzyme incubated for 30 min. with 0·2 ml. 10^{-1} *M* potassium cyanide; 0·2 ml. saturated 2 : 2′-diquinolyl; 0·2 ml. 10^{-1} *M* hydrazine sulphate; 0·2 ml. saturated solution of 'tetrabase'; 0·2 ml. 10^{-4} *M* *p*-chloromercuribenzoate, 0·2 ml. 4×10^{-3} *M* 2.6-dinitrophenol respectively before assay. Enzyme assay as in Table 1

Pot. cyanide	2 : 2′-Di-quinolyl	Hydrazine sulphate	'Tetrabase'	*p*-Chloro-mercuri-benzoate	2.6-Dinitro-phenol
67	35	78	40	82	75

Metal chelates inhibited the enzyme as did —SH inhibitors. The enzyme is likely to be a metallo-flavoprotein similar to others in the reduction sequence. It is also inhibited by uncoupling reagents, for example, dinitrophenol, so that a phosphorylation is involved in this reducing step. Further characterization of the enzyme and a study of its distribution in other organisms are now in progress.

The identification of a hyponitrite reductase in *Neurospora* supports the view that nitrate is reduced to ammonia in two-electron steps in plants and that the hitherto undetermined intermediate, postulated to have an oxidation state of + 1 for nitrogen, is probably hyponitrite. The stoichiometry of this reduction sequence may now be represented as follows:

$$HNO_2 + DPNH^* + H^+ \rightarrow HNO_2 + DPN^+ + H_2O$$
$$HNO_2 + DPNH + H^+ \rightarrow \tfrac{1}{2}H_2N_2O_2 + DPN^+ + H_2O$$
$$\tfrac{1}{2}H_2N_2O_2 + DPNH + H^+ \rightarrow NH_2OH + DPN^+$$
$$NH_2OH + DPNH + H^+ \rightarrow NH_3 + DPN^+ + H_2O$$

Net:
$$HNO_2 + 4DPNH + 4H^+ \rightarrow NH_3 + 4DPN^+ + 3H_2O$$

* In a number of these reactions reduced triphosphopyridine nucleotide can act as substitute for the reduced diphosphopyridine nucleotide (DPNH).

A full account of this and related work is in preparation.

Antonia Medina*
D. J. D. Nicholas

Agricultural Research Council
Unit of Plant Nutrition (Micronutrients),
Long Ashton Research Station,
University of Bristol.
Dec. 20.

* On leave from the Instituto de Edafologia y Fisiologia Vegeta Madrid.

[1] Taniguchi, S., Mitsui, H., Toyoda, T., and Egami, F., *J. Biochem.* (Japan), **40**, 175 (1952).
[2] Nason, A., Abraham, R. G., and Averbach, B. C., *Biochim et Biophys. Acta*, **15**, 159 (1954).
[3] Zucker, M., and Nason, A., *J. Biol. Chem.*, **213**, 463 (1955).
[4] Virtanen, A. I., and Rautanen, N., in "The Enzymes", edit. Sumner, J. B., and Myrback, K., **2**, 1089 (Academic Press, New York, 1952).
[5] Lees, H., "Biochemistry of Autotrophic Bacteria", 49 (Butterworths Sci. Pub., London).
[6] Nicholas, D. J. D., Nason, A., and McElroy, W. D., *J. Biol. Chem.*, **207**, 341 (1954).
[7] Russel, J. A., *J. Biol. Chem.*, **156**, 457 (1944).

Inhibition of Alanine Transaminase by the Hypoglycæmic Sulphonylurea Derivatives

Because of the recent interest in the mechanism of action of the two antidiabetic sulphonylurea derivatives, carbutamide (N_1 sulphanilyl N_2 *n*-butylcarbamide) and tolbutamide (N_1 *p*-toluylsulphonyl N_2 *n*-butylcarbamide), the effect of these compounds on the liver transaminase system was investigated, since inhibition of transamination reactions could lead to a decrease in the rate of neoglucogenesis.

The system used was modified from Cammaratta and Cohen[1], in that freshly prepared enzyme was used in all experiments. The enzyme was prepared by homogenizing fresh rat liver with 0·05 *M* potassium phosphate buffer. The homogenate was then differentially centrifuged, and the supernatant, after sedimentation of the mitochondria, was used for the experiment.

Thus the system consisted of: (1) Fresh liver enzyme, 0·2 ml.; (2) 0·5 ml. of 0·04 *M* α-ketoglutaric acid in 0·05 *M* sodium phosphate buffer, *p*H 7·4; (3) 1·0 ml. of 0·04 *M* D-L alanine in 0·05 *M* sodium phosphate buffer, *p*H 7·4; (4) 0·05 *M* sodium phosphate buffer, *p*H 7·4, to 3·0 ml.

When sulphonyl derivatives were added, these displaced a portion of the sodium phosphate buffer.

The system was incubated for 1 hr. at 37·2° C., and the reaction was stopped[1] by placing the flasks in water at 100° C. for 5 min.

The quantity of glutamic acid formed was estimated by determining the amount of carbon dioxide evolved as a result of the action of glutamic acid decarboxylase[2] obtained from *B. welchii* SR 12.

The following substances were tested in this system: (1) Carbutamide (N_1 sulphanilyl N_2 *n*-butylcarbamide); (2) tolbutamide (N_1 toluylsulphonyl N_2 *n*-butylcarbamide); (3) sulphacetamide (N_1 sulphonilylacetamide); (4) sulphadiazine (2 sulphanilamide pyrimidine). In all cases these were dissolved in 0·05 *M* sodium phosphate buffer and the *p*H adjusted to 7·4. All experiments were repeated four times.

The results obtained are shown in Fig. 1. Each point in the figure represents the mean of four experiments.

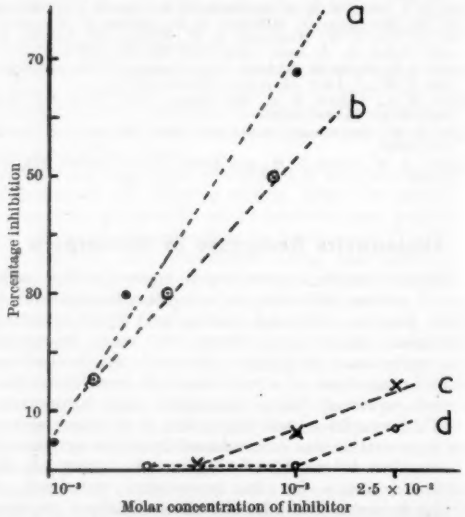


Fig. 1. *a*, Tolbutamide; *b*, carbutamide; *c*, sulphadiazine; *d*, sulphacetamide

Control experiments have shown that none of the substances tested significantly inhibited *B. welchii* SR 12 glutamic acid decarboxylase.

It is thus seen that carbutamide and tolbutamide significantly inhibit alanine transaminase, whereas sulphacetamide and sulphadiazine do not, and it is suggested that, by inhibiting transamination, such compounds decrease the rate of neoglucogenesis and hence lower the blood sugar.

I should like to thank the Australian National Health and Medical Research Council and Messrs. Eli Lilly and Co. for their support.

J. BORNSTEIN

Department of Biochemistry,
University of Melbourne,
Victoria.

[1] Cammaratta, P. S., and Cohen, P. P., *J. Biol. Chem.*, **187**, 439 (1950).
[2] Gale, E. F., *Biochem. J.*, **39**, 46 (1945).

The α–β Transformation in Keratin

THE α–β transformation, as observed by X-rays, has always held a position of central importance in any considerations on the molecular structure of keratin. It is therefore surprising that no quantitative investigation of the intensity variation of different reflexions comprising the X-ray diagram has been reported in the literature. It is generally accepted that the X-ray diagram of keratin changes little up to about 20 per cent extension (α-pattern), undergoes a rapid change between 30 and 50 per cent extension, and remains essentially unchanged during further extension (β-pattern)[1,2]. It is also claimed that the onset of the transformation always occurs at about 20 per cent extension irrespective of the medium in which the fibres are stretched[1], and that the general character of the transformation is unaffected by relaxation effects and a wide variety of chemical treatments[2].

This picture appears to require considerable modification in the light of work which is being carried out by these laboratories. A specially adapted 'Norelco' Geiger-counter diffractometer is being used to investigate the X-ray diagram of wool, in particular the α–β transformation. The specimen, which consists of a bundle of about a thousand Lincoln wool fibres, is held between the jaws of a stretching device inside a chamber at controlled temperature and humidity. With the existing equipment only three reflexions lend themselves to reliable observation: the meridional α-arc (a group of reflexions at about 5·1 A.), the equatorial β-spot at about 4·65 A., and the diffuse equatorial spot (which in porcupine quill tip is a group of reflexions) at about 9·8 A. common to both α- and β-patterns. The fine structure of the 5·1 A. and the 9·8 A. reflexions is not resolved by the present X-ray optical arrangement, which is designed for maximum diffracted intensity rather than optimum resolution.

Interesting results were obtained by observing the variation in peak intensity of these three reflexions with extension under different conditions of temperature and humidity of the fibre bundle. In general, the X-ray diagram of Lincoln wool starts changing at low extensions (5 per cent or less), contrary to previous reports; at 20 per cent extension the α–β transformation is generally well advanced, and there is frequently no evidence of a rapid change between 30 and 50 per cent extension. (Fig. 1 is a typical plot of peak intensity against percentage extension for the three reflexions.) It was also found that if the specimen is stretched in air, the α–β transformation proceeds more quickly at 20° C. than at 50° C., and that low humidity accelerates the α–β transformation.

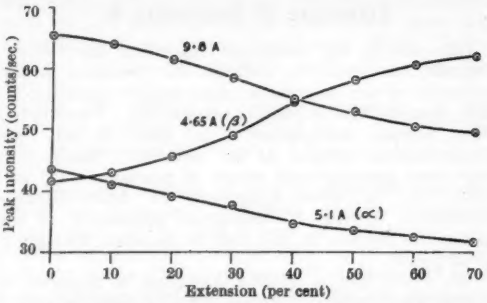


Fig. 1. Variation of peak intensity of the three prominent reflexions of the X-ray diagram of wool vs. percentage extension. In this particular test the X-ray diagrams were obtained at 20° C. and 0 per cent relative humidity; each increment of extension was carried out in water at 50° C.

Under some experimental conditions (for example, stretching in air from 0 to 20 per cent extension at 20° C. and 60 per cent relative humidity), it was observed that a decrease in the 5·1 A. reflexion is not accompanied by a related increase in the 4·65 A. reflexion. A similar lack of correspondence was noted when a specimen, previously stretched in air at 20° C. and 100 per cent relative humidity from 0 to 40 per cent extension, was allowed to relax at that extension in water at 50° C. for 10 min. Comparison of the X-ray diagrams before and after stress relaxation revealed no significant change in the intensity of the 5·1 A. and 9·8 A. reflexions, and a marked increase in the intensity of the 4·65 A. reflexion. Observations of this type do not accord well with Astbury's hypothesis of a 'molecular' α–β transformation[1,3], as this hypothesis is based to a large extent, either explicitly or by implication, on a 1 : 1 correspondence of the intensity variation of the 5·1 A. and 4·65 A. reflexions.

The results quoted were obtained after correcting the experimental results for air-scattering, polarization, absorption and variation of diffracting material during extension. The last two corrections are fairly large and are now being tested.

A full account of this work is at present being prepared for publication.

I am indebted to Prof. C. J. Milner, head of the School of Applied Physics at the New South Wales University of Technology, for the use of the Norelco Geiger-counter diffractometer and many other facilities extended during this investigation.

E. G. BENDIT

Wool Textile Research Laboratories,
Commonwealth Scientific and
Industrial Research Organization,
Physics and Engineering Unit,
The Hermitage,
338 Blaxland Road,
Ryde, New South Wales.
Nov. 27.

[1] Astbury, W. T., and Woods, H. J., *Phil. Trans. Roy. Soc.*, A, **232**, 333 (1933).
[2] Peters, L., and Woods, H. J., "Mechanical Properties of Textile Fibres", edit. by Meredith, 166 (North-Holland Pub. Co., Amsterdam, 1956).
[3] Astbury, W. T., and Bell, F. O., *Nature*, **147**, 696 (1941).

Structure of Bacitracin A

Reports in the literature[1] regarding the dodecapeptide, bacitracin A, indicate the presence in the molecule of the sequences phenylalanyl histidine (I) and phenylalanyl *iso*leucyl cysteine (II). Two related facts remain unexplained: (*a*) there is only one phenylalanine residue in the molecule; hence it is the same phenylalanyl which is present in (I) and (II); (*b*) on total hydrolysis of dinitrophenyl-bacitracin A, the dinitrophenyl derivative of the *iso*leucine residue in (II) can be isolated, though in poor yield[1].

To cover (*a*), a specific grouping is required in which the α-carboxyl carbon atom of phenylalanyl is bonded to the α-amino groups of histidine and *iso*leucyl. This structural element, —C(OH)(—NH—)—NH—, belongs to the system of groupings uniting the α-carboxyl and α-amino groups of amino-acids which was formulated in the cyclol theory[2]. According to this theory which, in a sense, is an amendment to the Fischer–Hofmeister theory of peptide structure, there can be one or two C—N bonds joining the α-carboxyl carbon atom of an amino-acid residue to the α-amino groups of other residues, and there can be one or two such bonds joining its α-amino group to the α-carboxyl groups of other residues. In consequence, the residues in the intact peptide structure are covalently bonded together not only in the CO—NH grouping uniting two residues through one C—N bond, but also in a variety of multiple peptide or cyclol groupings uniting three or more residues through two or more C—N bonds. Simplest among these multiple peptide groupings are the 1,1-diamino carbinol grouping, —C(OH)(—NH—)—NH—, just mentioned, and the diacyl amino grouping, —CO—N(—CO—)—, both containing two ¹C—N bonds and uniting three residues. The next simplest is the —C(OH)(—NH—)—N(—CO—)— grouping containing three C—N bonds and uniting four residues.

For a long time it was widely assumed that the cyclol groupings cannot exist. However, Stoll and his associates[3,4] have shown that one type of cyclol grouping exists in Nature, arguments to the contrary notwithstanding (see Stoll, *loc. cit.*). The case in point occurs in the peptide moiety of the five naturally occurring ergot alkaloids. Using two independent methods, high-temperature cleavage of the alkaloids and reduction with lithium aluminium hydride[5], Stoll and his associates established that the five tripeptides have the structure (III):

(III) R—CO—NH—C(R_1)(—CO—N(—CHR_2—CO)—)—O—C(—CH(—OH)—N(—CH_2—CH_2—)—)—

This structure[6] contains the C—N or diacyl amino-type of cyclol grouping mentioned above, which proves, not unexpectedly, to be unstable to hydrolysis. The skeleton formed by the N—C—C backbones of the three residues in (III) may theoretically decompose in two ways, as the multiple peptide grouping degenerates into single peptide groupings:

—N—C—C—N(—C—C—N—)—C—C to —N—C—C + N(—C—C—N—)—C—C

or to —N—C—C—N—C—C—N—C—C

Products of both these types emerged in hydrolytic experiments, but none in which the C—N fragment survived intact. The hydrolytic experiments demonstrate the nature of the skeleton of the tripeptides by implication (how else can the two types of product be accounted for?) but only by implication. To establish structure (III) directly, other than hydrolytic procedures were required. The inference may be drawn that a peptide can contain a functional element—a 'structural subtlety', to use Glenn's phrase[7]—which hydrolytic experiments do not reveal: in other words, the failure to find direct evidence of a multiple peptide grouping in partial hydrolysis products of a peptide does not prove that it is not present. It may also be concluded that the unstable diacyl amino grouping can remain intact so long as it is part of a larger structure of appropriate type. Regarding what is appropriate, this structure provides a first example. Seemingly the tricyclic nature of the atomic pattern is the main stabilizing feature.

Applying these ideas to bacitracin A, we account for (*a*) by introducing the C(—N)—N type of multiple peptide grouping containing an asymmetric carbon atom as in (IV):

(IV) —NH—CHR_{Phe}—C*(OH)(—NH—CHR_{His}—CO—)—CO—CHR_{Cys}—NH—CO—CHR_{Ileu}—NH—

To account for (*b*) it is then necessary to assume that the dinitrophenyl derivative of *iso*leucine is obtained from bacitracin A, not directly, but only after (IV) has degenerated into:

(V) —NH—CHR_{Phe}—CO—NH—CHR_{His}—CO—CO—CHR_{Cys}—NH—CO—CHR_{Ileu}—NH_2,

the peptide chain analogue of (IV). However, this assumption, that the C(—N)—N type of multiple peptide grouping shares with the C(—N)—C type the property of being unstable to hydrolysis, is far from being unplausible. It would carry with it the implication that other than hydrolytic procedures will be required to prove or disprove the suggestion made in (IV).

This suggestion does not rule out the presence, in the relatively large bacitracin molecule containing many pairs of NH and CO groups in (1,6) positions along a chain, of a number of other cyclol groupings involving, *inter alia*, the lysine and aspartic acid residues. These may include the cyclol-6 kernel[8] which contains six C—N bonds, introduces three

asymmetric carbon atoms and is potentially of interest in relation to the D-residues in bacitracin A and probably confers considerable stability on any molecule of which it is a part. Also remaining to be considered are other stabilizing features in the form of various particular ring closures in which *R*-groups take part. Included in these is the ring, already suggested[1], in which the cysteine side-chain is involved. A multiplicity of both types of ring closure would give the bacitracin molecule a geometrically well-defined atomic pattern, thus providing an explanation of its biological activity which is in tune with the modern concept of specificity.

DOROTHY WRINCH

Department of Physics,
Smith College,
Northampton,
Mass.

[1] Lockhart, I. M., and Abraham, E. P., *Biochem. J.*, **58**, 633 (1954). Lockhart, I. M., Abraham, E. P., and Newton, G. G. F., *ibid.*, **61**, 534 (1955). Hausmann, W., Weisiger, J. R., and Craig, L. C., *J. Amer. Chem. Soc.*, **77**, 723 (1955). Lockhart, I. M., and Abraham, E. P., *Biochem. J.*, **62**, 645 (1956).

[2] Wrinch, D., *Nature*, **137**, 411 (1936) *et seq.*; *Proc. Roy. Soc.*, A, **160**, 59 (1937) *et seq.*; *Phil. Mag.*, **31**, 183 (1941), etc.

[3] Stoll, A., Hoffman, A., and Petrzilka, T., *Helv. Chim. Acta*, **34**, 1544 (1951).

[4] Stoll, A., "Prog. in Chem. of Org. Nat. Products", **8**, 114 (1952).

[5] Cf. also Gaylord, N. G., *Exper.*, **10**, 351 (1954).

[6] In this structure, *R* is $C_{16}H_{19}N_5$, the lysergic acid residue. Residue two is L-phenylalanyl for ergotamine and ergocristine, L-leucyl for ergosine and ergokryptine and L-valyl for ergocornine. R_1 is methyl for ergotamine and ergosine and $CHMe_2$ in the three other cases. The third residue (prolyl in all cases) is also in the L-form.

[7] Glenn, A. L., *Quart. Rev. Chem. Soc., Lond.*, **8**, 192 (1954).

Microbiological Degradation of Cholic Acid

FOR the microbiological oxidation of cholic acid, two possible pathways different from that found in *A. faecalis*[1] or *E. coli*[2] can be suggested.

Previous studies[3] showed that *Streptomyces gelaticus* 1164, cultured in a synthetic medium containing cholic acid as the sole source of carbon, oxidized cholic acid (I) to an acid with melting point 280–282° (decomp.), which was presumed to be 7α-hydroxy-3 : 12-dioxo-Δ^4-bisnorcholenic acid (V). It has also been demonstrated[4] that *S. gelaticus* 1164, cultured in a medium containing cholic acid and glucose as the carbon sources, produced various intermediates such as 7α : 12α-dihydroxy-3-oxocholanic acid (II), 7α-hydroxy-3 : 12-dioxocholanic acid (III), 7α-hydroxy-3 : 12-dioxo-Δ^4-cholenic acid (IV) and the acid (V).

From the results of these experiments, a new oxidation pathway of cholic acid by *S. gelaticus* 1164 may be presumed as follows: I → II → III → IV → V →.

Subsequent studies of two unidentified bacteria, which can grow on a synthetic medium containing cholic acid as the sole source of carbon and are capable of converting cholic acid (I) to 7α : 12α-dihydroxy-3-oxo-Δ^4-cholenic acid (VI), have led to a consideration of another pathway for the oxidation of cholic acid by micro-organisms. The second pathway in these bacteria may be suggested as follows: I → II → VI →.

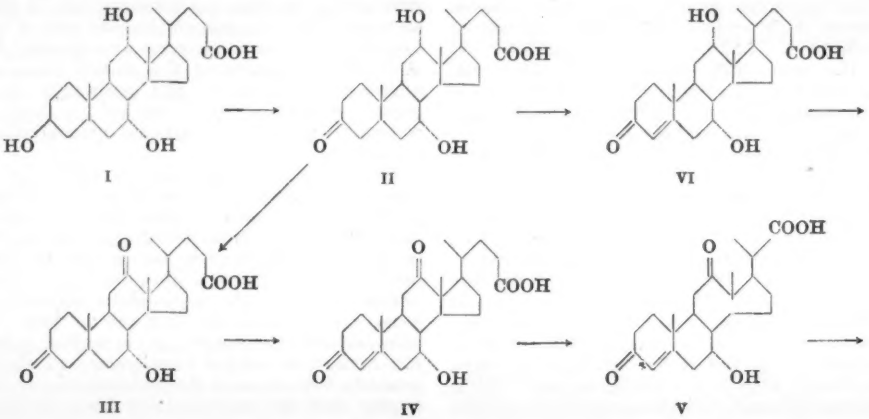
Much of the representation of our proposed pathways for cholic acid degradation by micro-organisms is still largely hypothetical, and the end product of cholic acid oxidation by these organisms has not yet been isolated. However, the following observations are still of interest.

(1) The mode of oxidation of cholic acid by *A. faecalis*[1] or *E. coli*[2] is the same as observed in the chemical oxidation by chromic acid or bromine[5]. On the other hand, the first step of cholic acid oxidation by our proposed pathways is related to Oppenauer oxidation[6] or dehydrogenation with Raney nickel[7].

(2) Since the two acids (IV) and (V) have the same constitution except for the difference in the side-chain, it seems quite probable that an introduction of the Δ^4-3-ketone or the 7α-hydroxy-Δ^4-3-ketone structures into the cholane nucleus is an indispensable process for the shortening of the side-chain of cholic acid.

In addition to the above *S. gelaticus*, six species of *Streptomyces*, namely, *S. californicus*, *S. flavogriseus*, *S. halstedii*, *S. rubescens*, *S. nitrosporeus* and *S. scabies*, have been found to be capable of utilizing cholic acid as the sole source of carbon and decomposing it via an intermediate (probably, acid IV or VI) containing a 7α-hydroxy-Δ^4-3-ketone structure[8].

This finding suggests a significance of the Δ^4-3-ketone structure for the microbial breakdown of bile acids, as is well known for the metabolism of other steroids by a variety of biological systems such as micro-organisms and animal tissues.



Further studies on the proposed pathways for microbial cholic acid degradation are in progress and will be reported in detail elsewhere.

Shohei Hayakawa
Takao Fujii

Department of Biochemistry,
Okayama University Medical School,
Okayama.

Yasuo Saburi

First Bacteriological Division,
Institute for Infectious Disease,
University of Tokyo.

Takeo Eguchi

Department of Bacteriology,
Okayama University Medical School,
Okayama.

[1] Hoehn, W. M., Schmidt, L. H., and Hughes, H. B., *J. Biol. Chem.*, **152**, 59 (1944).
[2] Schmidt, L. H., and Hughes, H. B., U.S. Patent 2,360,447 (1944).
[3] Hayakawa, S., *Proc. Japan Acad.*, **30**, 128, 133, 139 (1954). Hayakawa, S., Saburi, Y., Fujii, T., and Sonoda, Y., *J. Biochem.*, **39**, 733 (1956).
[4] Hayakawa, S., Saburi, Y., and Teraoka, H., *Proc. Japan Acad.*, **32**, 519 (1956). Hayakawa, S., Saburi, Y., and Akaeda, I., *J. Biochem.* (in the press).
[5] Charonnat, R., and Horeau, A., Fr. Patent 854,817 (1940) (*Chem. Abst.*, **42**, 2630 (1948)). Hoehn, W. M., and Linsk, J., *J. Amer. Chem. Soc.*, **67**, 312 (1945).
[6] Kuwada, S., and Morimoto, S., *Bull. Chem. Soc. Japan*, **17**, 147 (1942).
[7] Pietra, S., and Traverso, S., *Gazz. chim. Ital.*, **81**, 687 (1951).
[8] Saburi, Y., Hayakawa, S., and Fujii, T., *Japan J. Exp. Med.*, **25**, 151 (1955).

Enzymatic Synthesis of N-Glucuronic Acid Conjugates

Recent investigations have shown that the formation of glucosiduronic acids can be catalysed by cell-free preparations of mammalian liver with uridine diphosphate glucuronic acid acting as the glucuronic acid donor[1]. These preparations have been found to synthesize ether- as well as ester-type glucuronic acid conjugates[2]. We wish to report the enzymatic synthesis of another type of conjugate in which glucuronic acid is linked to nitrogen.

Incubation of aniline with the microsomes of guinea pig liver and uridine diphosphate glucuronic acid resulted in the disappearance of the free amino-group of aniline (Table 1). Little or no disappearance of the amine was observed in the absence of uridine diphosphate glucuronic acid or when this co-factor was replaced with uridine diphosphate glucose or glucuronolactone. Aniline was determined by extracting the compound into ethylene dichloride, returning it to a small volume of 0·1 *N* hydrochloric acid and measuring the amino-group by diazotization and coupling with N(1-naphthyl) ethylenediamine[3]. After incubating aniline with uridine diphosphate glucuronic acid and liver microsomes, the substrate which had not reacted was removed by extraction with ether and the aqueous residue was acidified. When this solution was kept at 50° C. for 10 min., its extraction with ethylene dichloride at *p*H 7·0 resulted in an almost complete recovery of the free amino-group (Table 1). The amine liberated on acid treatment was identified as aniline by the technique of comparative distribution ratios[3]. These observations suggested that the aniline which disappeared upon incubation with liver microsomes and uridine diphosphate glucuronic acid was converted to a labile

Table 1. Enzymatic Synthesis of Aniline N-Glucuronic Acid Conjugate

Washed microsomes, obtained from 200 mgm. of guinea pig liver, were incubated at 37° C. for 30 min. with 0·2 ml. 0·5 *M* phosphate buffer, *p*H 7·4, 20 μmoles magnesium chloride, 0·1 μmole aniline hydrochloride, co-factors and water to make a final volume of 2·0 ml.

Additions (μmole)	Aniline disappearing on incubation (μmole)	Aniline recovered on acid treatment (μmole)
None	0·008	0·005
Uridine diphosphate glucuronic acid (0·09)*	0·055	0·047
Uridine diphosphate glucose (0·4)	0·002	0·002
Glucuronolactone (0·1)	0·005	0·003

* Prepared enzymatically from uridine diphosphate glucose with uridine diphosphate glucose dehydrogenase (ref. 1,*d*) and diphosphopyridine nucleotide.

glucuronic acid conjugate, presumably aniline N-glucosiduronic acid.

At *p*H 6·0 and *p*H 5·0, the aniline conjugate was hydrolysed to the extent of 47 and 68 per cent respectively within 30 min. at 37° C. Likewise, other investigators have found that N-glucuronic acid conjugates isolated from urine were extremely labile in acid solutions[4]. In the presence of either mammalian or bacterial β-glucuronidase, the rate of hydrolysis of the aniline glucuronic acid conjugate was no greater than that observed with the boiled enzymes.

Incubating amines such as *p*-phenetidine and *p*-toluidine with guinea pig microsomes and uridine diphosphate glucuronic acid resulted in the disappearance of the amino-groups and their reappearance after treatment with acid. The fact that amines[4] (4,4′diaminodiphenyl sulphone, 2-naphthylamine) and amino-acids[5] have been found to be excreted as glucuronic acid conjugates after their administration to animals, together with our observation that several amines can readily form conjugates *in vitro*, would suggest that this may constitute an important pathway in the metabolism of amino-compounds.

Nuclei, mitochondria, microsomes and the soluble fraction of guinea pig liver[6] were examined for their ability to form the glucuronic acid conjugate of aniline in the presence of uridine diphosphate glucuronic acid. Only the microsomes showed enzymatic activity, as was found previously with phenolic substrates[1]. This observation suggested that the same enzyme may be involved in the formation of all types of glucuronic acid linkages. Such a possibility was rendered more likely when it was shown that whether the substrate was a phenol or an amine, the *p*H optimum and the rate of inactivation of the microsomal enzyme were similar. Furthermore, the formation of the aniline conjugate was inhibited by phenolic and carboxylic acceptors. Similar conclusions were reached by Dutton with respect to phenol and carboxyl glucosiduronic acid synthesis[7].

That an amino-compound can react with uridine diphosphate glucuronic acid to give an N-glucosiduronic acid is consistent with the previous findings that other nucleophilic (electron donating) reagents, such as alcohols, phenols and carboxylic acids, can react in the same way; they have in common the ability to attack the electrophilic anomeric carbon atom of uridine diphosphate glucuronic acid. Furthermore, since the glycosidic bond in uridine diphosphate glucuronic acid has the α-configuration[7], whereas the products formed are β-glucosiduronic acids, it would appear that the enzymatic synthesis proceeds by a

backwards attack, so that the reaction has the characteristics of a nucleophilic substitution.

JULIUS AXELROD
JOSEPH K. INSCOE
National Institute of Mental Health,
National Institutes of Health,
Bethesda, Maryland.
GORDON M. TOMKINS
National Institute of Arthritis and
Metabolic Diseases,
National Institutes of Health,
Bethesda, Maryland.
Dec. 20.

[1] (*a*) Dutton, G. J., and Storey, I. D. E., *Biochem. J.*, **53**, 37 (1953); (*b*) **57**, 275 (1954). (*c*) Smith, E. E. B., and Mills, G. T., *Biochim. Biophys. Acta*, **13**, 386 (1954). (*d*) Strominger, J. L., Kalckar, K. M., Axelrod, J., and Maxwell, E. S., *J. Amer. Chem. Soc.*, **76**, 6411 (1954). Isselbacher, K., and Axelrod, J., *J. Amer. Chem. Soc.*, **77**, 1070 (1955).
[2] Dutton, G. J., *Biochem. J.*, **60**, 19 (1955).
[3] Brodie, B. B., and Axelrod, J., *J. Pharmacol. and Exp. Therap.*, **94**, 22 (1948).
[4] Boyland, E., and Manson, D., *Biochem. J.*, **60**, 2 (1955). Bushby, S. R. M., and Woiwod, A. J., *Biochem. J.*, **63**, 406 (1956).
[5] Pollack, R. L., and Eades, jun., C. H., *Science*, **119**, 510 (1954).
[6] Schneider, W. C., *J. Biol. Chem.*, **176**, 259 (1948).
[7] Strominger, J. S., Maxwell, E. S., Axelrod, J., and Kalckar, H. M., *J. Biol. Chem.* (in the press).

Effect of the Interaction between Chelating Agents on their Fungitoxicity

THE role of chelation in the mechanism of action of 8-hydroxyquinoline ('oxine') against fungi has been reviewed by Horsfall[1] and Hollingshead[2]. The increased bactericidal and fungicidal activity of this compound in the presence of Cu^{2+} has been ascribed to the rapid penetration of the cell wall by the highly lipophilic 1 : 2 copper : oxine complex[3,4], which may dissociate within the cell to a more toxic substance or substances.

More recently, Zentmyer and Rich[5] demonstrated that the toxicity of oxine and copper oxinate to spores and mycelium of *Aspergillus niger* van Tiegh. was reversed on Czapek's agar by L-histidine (0·5 per cent) or L-cysteine (0·5 per cent), both of which were shown to compete for the copper and liberate free oxine. A similar biological effect was reported by Heath and Clark[6], who showed that the inhibition of root growth of wheat seedlings by 10^{-5} *M* oxine was partially reversed by ethylenediamine tetraacetic acid (EDTA) at a concentration as low as 10^{-11} *M*.

We have examined the fungistatic properties of a series of 5-*n*-alkyl oxines[7] towards *A. niger*. The fungus was grown on a glucose–mineral salts–agar medium (pH 5·0) without added trace metals. The compounds were incorporated in the medium at a final concentration of 10^{-4} *M*, and the growth of the mycelium (at 25°) was assessed over the 2–4 day period after inoculation[8]. The fungistatic activity of the compounds rose to a maximum at a chain-length of 5 or 6 carbon atoms. In another experiment, the addition of Cu^{2+} (10^{-4} *M*) markedly reduced the activity of 5-*n*-amyl- and 5-phenyl-oxine (10^{-4} *M*). This effect could be reversed by the addition of the disodium salt of ethylenediamine tetraacetic acid (10^{-3} *M*), which presumably liberated the free oxines. Oxine itself, by contrast, was active in the presence of Cu^{2+}, and inactive in the presence of excess ethylenediamine tetraacetic acid. All three compounds showed intermediate activity in the basal medium alone, in which the only trace metals present arose from impurities in the constituents. Neither Cu^{2+} nor ethylenediamine tetraacetic acid reduced growth significantly in the absence of oxines (Table 1).

Table 1. MEAN RADIAL MYCELIAL GROWTH (MM./DAY) OF *A. niger* IN THE PRESENCE OF THREE 8-HYDROXYQUINOLINES (10^{-4} *M*)

Compound	Cu^{2+} and EDTA added	Cu^{2+} added	EDTA added	No addition
Oxine	12·6	0·0	12·9	4·4
5-Phenyl oxine	0·0	12·2	0·0	5·4
5-Amyl oxine	0·0	9·8	0·0	2·0
Control	12·8	13·3	13·6	12·9

Least significant difference between means ($P = 0·05$) : 2·70
($P = 0·01$) : 3·70
($P = 0·001$) : 5·04
The interactions Cu^{2+}/oxines and oxines/EDTA are both significant ($P < 0·001$)

The fungistatic activity of the 5-*n*-alkyl oxines follows the pattern normally encountered in such a homologous series[9]. Owing to their greater lipoid solubility, unchelated molecules of 5-amyl and 5-phenyl oxines are able to penetrate the fungal cell wall more rapidly than those of oxine itself, which is more active in the form of its 1 : 2 copper complex[4]. It is suggested that the decrease in the activity of 5-amyl and 5-phenyl oxines in the presence of Cu^{2+} may arise from too low an aqueous solubility of the corresponding 1 : 2 copper : oxine complexes.

Experiments on the effect of ethylenediamine tetraacetic acid on the toxicity of a wider range of chelating agents to the mycelium of *A. niger* will be described elsewhere. Preliminary results indicate that the addition of an excess of ethylenediamine tetraacetic acid to the basal medium results in a significant increase in the fungistatic activity of a number of compounds, including 5 : 7-dichloro-oxine (10^{-5} *M*) and 2-mercaptobenzthiazole (10^{-4} *M*). It is of interest that both these compounds have already been reported to be more active in their unchelated form than as their copper or zinc chelates respectively[10,11].

In order to test an unchelated molecule *per se* it is first necessary to remove metal ions from the culture medium. This may virtually be achieved, and fungal growth still supported, by the incorporation of an excess of a second chelating agent, itself non-toxic. Such a procedure may prove valuable, not only in studies on the mode of biological action of chelating agents, but also in their application in the control of bacteria and fungi.

R. J. W. BYRDE
D. WOODCOCK
Department of Agriculture and Horticulture,
University of Bristol,
Long Ashton.
Dec. 19.

[1] Horsfall, J. G., "Principles of Fungicidal Action", Chap. 9 (Chronica Botanica Co., Waltham, Mass., 1956).
[2] Hollingshead, R. G. W., "Oxine and its Derivatives", Chap. 46 (Butterworth, London, 1956).
[3] Albert, A., Gibson, M. I., and Rubbo, S. D., *Brit. J. Exp. Path.*, **34**, 119 (1953).
[4] Greathouse, G. A., Block, S. S., Kovach, E. G., Barnes, D. E., Byron, C. W., Long, G. G., Gerber, D., and McClenny, J., 2nd Ann. Rep. Engineer Research and Development Labs., Fort Belvoir, Va., U.S.A. (1954) (cited by Hollingshead, ref. 2).
[5] Zentmyer, G., and Rich, S., *Phytopath.*, **46**, 33 (1956).
[6] Heath, O. V. S., and Clark, J. E., *Nature*, **178**, 600 (1956).
[7] Woodcock, D., *J. Chem. Soc.*, 4391 (1955).
[8] Byrde, R. J. W., and Woodcock, D., *Ann. App. Biol.* (in preparation).
[9] Ferguson J., *Proc. Roy. Soc.*, B, **127**, 387 (1939).
[10] Block, S. S., *Agric. and Food Chem.*, **3**, 229 (1955).
[11] Dimond, A. E., and Horsfall, J. G., *Science*, **97**, 144 (1943).

Radiolysis of Tri-*n*-butyl Phosphate

Tri-*n*-butyl phosphate in an inert paraffinic diluent is of interest for the solvent processing of pile-irradiated nuclear fuels[1,2]. If the specific activity of the process solution should be very high, radiation damage to the solvent will have a significant effect on plant efficiency, since it leads to the simultaneous production of di-*n*-butyl phosphate and mono-*n*-butyl phosphate. Under certain conditions, these acidic esters exhibit a high complexing power towards plutonium, uranium and some fission-products[3]. The consequences are poor decontamination of the fuel material and reduced efficiency in stages designed to wash back these materials into an aqueous phase.

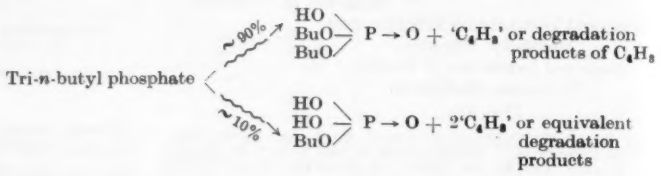
Experiments carried out in recent years by us have given the following results. Irradiation of pure tri-*n*-butyl phosphate with 1 MeV. electrons from a Van de Graaff generator gave yields of acid phosphate and gas, the amounts of which were proportional to energy input (Williams, T. F., and Wilkinson, R. W., unpublished work). The acidic material was extracted from the solvent and was shown by infra-red analysis and paper-chromatography[4] to consist of two acids identified as di- and mono-*n*-butyl phosphate. The ratio of the yields of the two acids was constant over a wide range of energy deposition. These yields, expressed as molecules per 100 eV. of energy absorbed, were,

G (di-*n*-butyl phosphate)	=	1·5
G (mono-*n*-butyl phosphate)	=	0·17
G (gas, volatile at − 196° C.)	=	1·1

This non-condensable gas consisted of 95 per cent hydrogen and 5 per cent methane. The C_3 hydrocarbons were separated at − 120° C., and analysis using the Blacet–Leighton technique[5] indicated a mixture of ethane and ethylene with a total $G = 0{\cdot}2$. At higher temperatures (− 70° C.) a mixture of C_3 and C_4 hydrocarbons was collected. The solubility of these gases in the solvent caused difficulty in their extraction and some variation in the measured yield, $G = 0{\cdot}4$. Higher hydrocarbons may have been present, but could not be extracted by the technique employed. At the high rate of energy input used ($3{\cdot}5 \times 10^{19}$ eV./ml./min.), no difference could be detected in the acid yield between irradiations carried out in air and *in vacuo*.

If, prior to irradiation, tri-*n*-butyl phosphate was saturated with water to give a solution containing 6·4 wt. per cent of water, a total yield G(di- + mono-*n*-butyl phosphate) = 0·9 was obtained (Williams, T. F., and Wilkinson, R. W., unpublished work). This decrease in yield cannot be explained simply on the partition of energy absorption by the two components. A sample of water-saturated tri-*n*-butyl phosphate which had been irradiated to a total dose of 8×10^{21} eV./ml. was also subjected to vapour-phase chromatographic analysis using a Griffin V.P.C. apparatus, type *S* 18–750. The chromatogram was compared with one obtained from a non-irradiated sample spiked with 5 per cent *n*-butanol and 5 per cent *n*-butyraldehyde. The non-irradiated sample gave very clear alcohol and aldehyde peaks. No trace of them could be found in the irradiated sample (Rigg, T., unpublished work). It was concluded that these substances were not major products of the radiolysis of tri-*n*-butyl phosphate.

The suggestion of Cathers[6] that a radiation-induced hydrolysis is responsible for the breakdown of tri-*n*-butyl phosphate is not supported by these findings. The actual mechanism of radiolysis may involve both 'radical' and 'ultimate-molecule' processes, arising from a 'direct' effect caused by energy absorbed by the ester itself.



It is conceivable that some of the hydrocarbon residue products may contain more than four carbon atoms formed by radical recombination[7]. Our failure to detect these may account for the lack of a stoichiometric balance between the production of the acidic esters and total carbon measured in terms of gaseous products.

We wish to express our gratitude to Messrs. Marchon Products, Ltd., of Whitehaven, who kindly placed the vapour phase chromatography apparatus at our disposal, and to the United Kingdom Atomic Energy Authority for permission to publish this communication.

T. F. Williams
R. W. Wilkinson
Chemistry Division, A.E.R.E.,
Harwell, Berks.

T. Rigg
Research and Development Branch,
U.K.A.E.A. (I.G.), Windscale Works,
Cumberland. Dec. 13.

[1] Goldschmidt, B., *et al.*, Geneva Conference on the Peaceful Uses of Atomic Energy, **9**, 492 (1955).
[2] Culler, F. L., Geneva Conference on the Peaceful Uses of Atomic Energy, **9**, 464 (1955).
[3] Tomlinson, R. E., Geneva Conference on the Peaceful Uses of Atomic Energy, **9**, 511 (1955).
[4] Wade, H. E., and Morgan, D. M., *Nature*, **171**, 529 (1953).
[5] Blacet, F. E., and Leighton, P. A., *Indust. Eng. Chem.* (Anal. Ed.), **3**, 266 (1931). Blacet, F. E., Macdonald, G. D., and Leighton, P. A., *ibid.*, **5**, 272 (1933).
[6] Cathers, G. I., Geneva Conference on the Peaceful Uses of Atomic Energy, **7**, 490 (1955).
[7] Dewhurst, H. A., *J. Chem. Phys.*, **24**, 1254 (1956).

Dispersion of the Photoelastic Constants of Fused Silica

Among amorphous substances, vitreous silica occupies a favoured place as it consists of a single chemical constituent. A systematic investigation of the dispersion of its photoelastic constants is therefore of great importance. Filon and Harris[1] measured the stress optical coefficient of fused silica over the range of wave-length 4600–6500 A. Although they reported the presence of dispersion of the stress optic coefficient, the results were not conclusive, for the range of wave-lengths studied by them was restricted. The piezo-optic constants q_{11} and q_{12} and the stress optical coefficient $C \left[= \frac{n^3}{2} (q_{12} - q_{11}) \right]$ have been measured by us for the range of wave-lengths 2250–5700 A. The specimen of fused silica used in the present experiments was obtained from the Thermal Syndicate, Ltd., England. The values of q_{11} and q_{12}

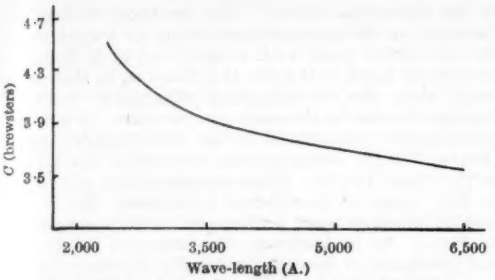


Fig. 1. The stress optical coefficient of vitreous silica

were determined by measuring the fringe shifts for known additional loads[2], and the value of C was measured by adopting the method used by Filon and Harris, which was suitably modified to get more accurate results. In both cases a photographic technique was used.

The value of q_{12} increases from $2{\cdot}35 \times 10^{-13}$ at 2300 A. to $2{\cdot}49 \times 10^{-13}$ at 5500 A., and that of q_{11} increases from $-\ 0{\cdot}24 \times 10^{-13}$ at 2300 A. to $+\ 0{\cdot}11$ 10^{-13} at 5500 A. (q_{12} and q_{11} are given in c.g.s. units). The variation of the stress optical coefficient C obtained from direct measurements is shown in Fig. 1. Mean values from Filon and Harris's paper have been used for plotting the curve in the region 5500–6500 A. The value of C decreases from 4·54 brewsters at 2300 A. to 3·55 brewsters at 6500 A. As is to be expected, the dispersion of the stress optical coefficient increases as one approaches the transmission limit in the ultra-violet. The present investigation, besides providing data for the value of C over the entire region of transmission of fused silica in the visible and ultra-violet, clearly establishes the existence of dispersion of its photoelastic constants.

There is a very good agreement between the values of $(q_{12}-q_{11})$ calculated from the measured values of C and those obtained directly from the measured values of q_{12} and q_{11} for the different wave-lengths. The quantity $(q_{12}-q_{11})$ exhibits a dispersion of about 10 per cent in the region of wave-lengths studied.

Details of this work describing the methods of measurement, etc., will appear in due course in the *Journal of the Indian Institute of Science*.

E. S. Jog
R. S. Krishnan

Physics Department,
Indian Institute of Science,
Bangalore 3. Dec. 26.

[1] Filon, L. N. G., and Harris, F. C., *Proc. Roy. Soc.*, A, **130**, 410 (1931).
[2] Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, A, **25**, 208 (1947).

Ionization Gauge Detector for Gas Chromatography

The development of high-sensitivity detectors for the chromatographic analysis of gaseous mixtures is of importance in the determination of substances present in very small amounts. A sensitive ionization gauge detector has been developed in this laboratory which makes use of the fact that the ionization potential of the helium carrier gas (24·5 volts) is very much greater than that of most other volatile substances. The ionization potentials for hydrocarbons, for example, range from 8 to 14 volts.

The gauge and adjustable metal leak associated with it are shown in Fig. 1. A very small fraction of the gas stream from the chromatographic column passes through the leak into an R.C.A. 1949 ionization gauge with the glass envelope modified so that the gas flows between the gauge components. The potential difference between the filament and the grid is adjusted to approximately 18 volts, a value not sufficient to produce ions when helium only is flowing through the gauge and consequently there is no plate current. When a substance of lower ionization potential is carried into the gauge, ions are formed. The ion current from the plate is amplified in the usual manner and recorded on a Leeds and Northrup 'Speedomax' recorder.

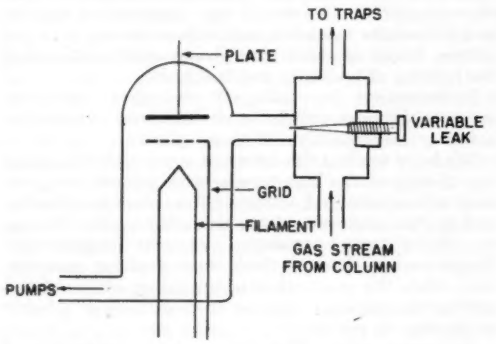


Fig. 1. Schematic diagram of gauge and leak

Typical operating conditions for the gauge are: pressure in the envelope, 0·2 mm. mercury; filament emission 5 m.amp.; grid potential + 18 volts; plate potential − 27 volts.

The sensitivity obtained so far is at least 200 times that given by a thermistor-type thermal conductivity cell, and compares favourably with the value reported recently by Harley and Pretorius[1]. This sensitivity has been achieved by using only a very small fraction (less than 0·5 per cent) of the gas stream emerging from the column, thus leaving almost all the effluent stream unchanged and available for subsequent trapping and identification if this is desired. A significant feature of the gauge is that its performance is insensitive to ambient temperature changes and also to changes in pressures and flow-rate in the main gas stream. This latter factor is of great importance in analyses done with rising column temperature during which marked reductions in flow-rate occur.

It may be possible to increase the sensitivity of the gauge by incorporating screen and suppressor grids. A further increase should be obtained by replacing the tungsten filament with an iridium filament to increase the stability of the emission.

A detailed report will be published later. We are grateful to Messrs. D. C. Frost and E. W. C. Clarke for advice and assistance.

S. A. Ryce
W. A. Bryce

Department of Chemistry,
University of British Columbia,
Vancouver, Canada.
Jan. 2.

[1] Harley, J., and Pretorius, V., *Nature*, **178**, 1244 (1956).

Infra-red Spectra of High-temperature Phases of Kaolinite and Halloysite

Kaolinite and halloysite in the temperature-range 650–900° C. do not show any pronounced X-ray interference. In this range metakaolinite is formed; its Si—O hexagonal network remains more or less unchanged, while the octahedral sheet is deformed in absence of OH-groups[1,2]. In kaolinite and halloysite, dehydration brings about a random arrangement in the direction of the *c*-axis. In pure and perfectly crystallized kaolinite, heated in the differential thermal apparatus at a velocity of 10 deg. C. per min. just above the exothermal maximum, X-ray examination reveals γAl_2O_3 and mullite, whereas in halloysite only γ-alumina appears. In halloysite heated in the same way, mullite is observed[3] only above 1,100° C. As the X-ray diagrams of mullite and sillimanite resemble each other closely, it is not certain which of these two phases is formed during the heating of kaolinite and halloysite.

Examination by infra-red radiation, however, seems to throw more light on the structure and enables a better identification of these phases.

We have studied the infra-red spectra (in the range $\lambda = 2–15\mu$) of the high-temperature phases of a pure and well-crystallized kaolinite from Skočaj (Croatia) and a pure halloysite from Gradešnica (Macedonia), in 'Nujol' and potassium bromide respectively. Fractions less than 2μ thick were used for examination, while the products of heating were obtained in a differential thermal apparatus at a heating velocity of 10 deg. C. per min.

Infra-red spectra of the kaolinite, between 8·7 and 10·4μ, show four absorption bands with maxima at 9·1, 9·3, 9·6 and 9·9μ which can be ascribed to the Si—O linkage, octahedral alumina sheet giving an absorption band with maximum at 10·9μ, whereas the absorption band at 2·7μ belongs to OH-radicals bound in the octahedral sheet[4]. In the metakaolinite range, the products of heating no longer show the absorption band at 10·9μ (indicating the complete dislocation of the octahedral sheet) or at 2·7μ (indicating absence of OH-groups). In the same samples left in the open for 20 days, no bands of adsorbed water at 3–4μ and 6μ could be observed. In metakaolinite, absorption bands of kaolinite between 8·7 and 10·4μ are replaced by a wider band between 7·9 and 10·5μ which, as regards the absorption bands of kaolinite, is shifted towards shorter wave-lengths. This band is considerably narrower and at a shorter wave-length as compared with the corresponding absorption band of aluminium – silica gel of the same composition heated at the same temperature. This suggests a greater order in the Si—O sheet. The decomposition of metakaolinite is accompanied by an increase and widening of the same absorption band which becomes less and less pronounced because of the intensified absorption in the range 10–15μ. Infra-red spectra of the products heated at 1,200–1,350° C. are more like those of mullite than of sillimanite[5].

It can be shown by the infra-red spectra that there are some essential differences in the properties of the high-temperature phases of kaolinite and halloysite, specially in the X-ray amorphous metakaolinite range. The infra-red spectrum of the halloysite examined shows the absorption band of the octahedral alumina sheet with a maximum at 10·9μ, Si—O maximum at 9·6μ, a maximum at 2·92μ (H_2O in interlayers), and a maximum at 2·75μ (OH-groups in the octahedral sheet). The products of heating halloysite in the metakaolinite range no longer show the absorption band with a maximum at 10·9μ; the absorption band of the Si—O linkage is, in this case, wider than the corresponding absorption band of kaolinite heated to the same temperature. It already becomes less pronounced in the metakaolinite range (above 700° C.) owing to the intensified absorption in the range 10–15μ. After crystallization of γAl_2O_3 in the range of exothermal maximum, the Si—O linkage becomes more pronounced, with a maximum at 9·1μ. As in kaolinite, the infra-red spectra of the products of heating halloysite between 1,200° and 1,350° C. are more like the infra-red spectra of mullite than those of sillimanite.

The differences between kaolinite and halloysite in the metakaolinite range regarding the absorption bands of bound and free OH-groups are of special interest. The products of dehydration of halloysite in the range of 650–850° C., unlike those of kaolinite, are very hygroscopic, showing an absorption band between 2·5 and 3·5μ with a maximum at 2·95μ, as well as an absorption maximum at 6·15μ. Taking certain precautions, we have succeeded in protecting the products obtained at 680° and 720° C. (proved amorphous by X-rays) from humidity, so that the infra-red spectra obtained showed a very poor absorption band at 6·15μ, while the large band between 2·5 and 3·5μ was split into two smaller bands with the maxima at 2·95 and 2·71μ. While the occurrence of the bands at 6·15 and 2·95μ can be assigned to adsorbed water, the band at 2·71μ suggests free OH-groups probably bound to AlO-groups. It appears very likely that the crystallization nuclei of γAl_2O_3 are already formed in the metakaolinite range, and that their formation is enhanced by the retarded OH-groups, which have a stabilizing effect on that compound[6].

We thank Prof. V. Prelog for having made it possible for us to prepare the infra-red spectra, Dr. M. Hadži for many valuable discussions and the preparation of some additional spectra.

V. Stubičan
Yugoslav Academy of Science and Arts,
Zagreb.

Hs. H. Günthard
Organic Chemistry Laboratory,
Federal Institute of Technology, Zurich.

[1] Brindley, G. W., *Min. Mag.*, **30**, 574 (1955).
[2] Roy, R., Roy, D. M., and Francis, E. E., *J. Amer. Ceram. Soc.* **38**, 198 (1955).
[3] Glass, H. D., *Amer. Mineral.*, **39**, 193 (1954).
[4] Hunt, John M., Wisherd, Mary P., and Bonham, Lawrence C., *Anal. Chem.*, **22**, 1478 (1950).
[5] Roy, R., and Francis, E. E., *Amer. Mineral.*, **38**, 725 (1953).
[6] de Boer, J. H., and Houben, G. M. M., Proc. Int. Symp. React. Solids, 1952, p. 237.

Density of Marine Benthic Communities off West Africa

Recently, Thorson[1] has suggested that a series of related marine benthic communities might occur on level sea-bottoms from the Arctic to the tropics, similar communities occurring on similar deposits irrespective of latitude, and he directed attention to the possibility of studying, in these communities, growth-rates and recruitment of stock under similar ecological conditions in cold and in warm seas.

Table 1

		Spp./sample	Indiv./m.²	gm./m.²
Estuarine stations (< 10 m.)				
	Sand	2·30	26	0·56
	Muddy sand	7·00	120	15·30
	Sandy mud	19·70	563	12·41
	Mud	7·70	62	6·72
Offshore stations				
By deposit	Sand	10·60	46	7·45
	Shelly sand	15·10	61	12·10
	Muddy sand	18·20	69	10·43
	Shelly mud	17·90	76	13·20
	Sandy mud	14·00	103	11·25
By depths	0–40 m.	15·90	71	13·50
	41–80 m.	19·10	67	11·18
	81–120 m.	9·00	31	3·04
	121–160 m.	9·60	56	4·12
	161–200 m.	5·25	26	5·89
	201–240 m.	8·00	22	2·90

Although there is now fairly extensive knowledge of the density of benthic communities in temperate, boreal and arctic waters, there is no comparable information from tropical seas; Sparck[2] has presented data derived from a few quantitative stations worked in the Gulf of Guinea with a van Veen sampler, but these were mostly in deep water off the continental shelf. All the other quantitative surveys in the tropics appear to have been concerned with the fauna of coral reefs.

As a preliminary to the study of the productivity of the West African benthos, a quantitative survey with bottom samplers has now been completed off Sierra Leone, and this appears to confirm Thorson's postulate, for the results have shown the presence of communities which are the counterparts of those occurring on similar deposits in colder seas. The survey consisted of a total of 105 stations which were worked with 0·1 m.² van Veen[3] and Smith[4] samplers, and covered all the main ecological conditions in the area from the coastal mangrove creeks to the upper part of the continental slope. A sample of 0·5 m.² was taken at almost all the stations.

The standing crop of the benthos was found to vary with depth and the nature of the deposits in the same way as in temperate seas; in general, there was a decrease in the richness and variety of the fauna in deeper water, although this was masked to some extent by the effect of the nature of the deposits. The main results of the survey are summarized in Table 1.

The biomass and the numbers of species and individuals per unit area appear to be lower than figures which would be considered normal outside the tropics, and are lower than figures obtained by Sparck farther along the Guinea Coast. But such comparisons are by no means satisfactory in the present state of benthos studies, and in the absence of a standard and accepted method of expressing quantitative results. The biomass figures given in Table 1 are alcohol weights, as were used by Holme[5], Petersen[6], Zenkewitch[7] and others, and it is only with the results of these authors that comparisons can be made.

Table 2

	Spp./sample	Indiv./m.²	gm./m.²
Sierra Leone:			
Estuarine stations	8·90	172	7·20
Offshore stations	15·90	71	11·70
English Channel:			
Offshore stations	20·45	166	40·30
Off Volta/Congo Rivers:			
10–20 m.			30–40
To 100 m.			1–10

In Table 2 the mean results for estuarine and offshore stations are compared with Sparck's figures and with figures extracted from Holme's results.

The western part of the English Channel in which Holme worked is known to be less rich than other areas around Britain—for example, much of the North Sea—but his results are selected for comparison because of similarities in sampling and evaluating techniques. Figures much higher than those quoted above are common in the Arctic, where Zenkewitch divided a very large sea area into zones characterized by having a biomass of 20, 50, 100, 200 or 300 gm./m.².

The Sierra Leone survey has shown that tropical marine communities do not necessarily contain high numbers of species and individuals compared with counterpart communities in colder waters; it is significant that only about 800 species of marine invertebrates were identified in the grab survey and in a concurrent dredging survey, compared with the total of 757 that Jones[8] found in work of rather similar scope off the Isle of Man. The rich and varied faunas on tropical coral reefs are perhaps expressions of the ecological diversity of that environment, and on level sandy or muddy bottoms in the tropics there may, in fact, be no great proliferation of species. The numbers of individuals may depend on quite a different factor, namely, the general nutrient supply in the water mass concerned.

It is hoped that these first estimations of the standing crop will serve as a basis for the studies of productivity which are planned as the second stage of the benthos survey off Sierra Leone.

ALAN R. LONGHURST
West African Fisheries Research Institute,
Freetown. Dec. 6.

[1] Thorson, G., *J. Mar. Res.*, **14**, (4), 387 (1955).
[2] Sparck, *R., Nature*, **168**, 112 (1951).
[3] Thamdrup, H. M., *J. Cons. Int. Explor. Mer*, **18** (2), 206 (1933).
[4] Smith, W., and MacIntyre, A. D., *J. Mar. Biol. Assoc., U.K.*, **33**, 257 (1954).
[5] Holme, N. A., *J. Mar. Biol. Assoc., U.K.*, **32**, 1 (1953).
[6] Petersen, C. G. J., and Boysen Jensen, P., *Rep. Dan. Biol. Station*, **20** (3), 1 (1911).
[7] Zenkewitch, L., *et al.*, *J. Cons. Int. Explor. Mer*, **3**, 371 (1928).
[8] Jones, N. S., *J. Anim. Ecol.*, **20** (1), 132 (1951).

A Root Disease of *Piper nigrum* L. in Sarawak caused by a Species of *Phytophthora*

ROBERTSON[1] reported a serious root disease of unknown cause on black pepper (*Piper nigrum* L.) in Sarawak which, post-war, first attracted attention in 1952[2]. Sundararaman[3], Venkata Rao[4], and Chowdhury (personal communication, August 1956) stated that a *Phytophthora* sp. attacked pepper in India. In an Indian pepper survey, Krishna Menon[5] found wilt diseases of this plant not serious, and obscure in origin. In Indo-China a *Phytophthora* sp. isolated by Barat[6] from pepper was, apparently, not of primary importance. Muller[7] showed that a wilt of the same plant in Indonesia was caused by a species of this genus. He named it *P. palmivora* var. *piperis*. In Malaya, Thompson[8] isolated a member of the same genus from pepper roots sent to him from Sarawak in 1940.

In May 1956, a *Phytophthora* sp. was identified from dying vines. It was isolated from the cortical region of surface-sterilized main roots and stems

of such vines at and below ground-level, where an abrupt transition between healthy and necrotic tissue occurred. Here were found non-septate, hyaline and intercellular hyphæ. The sterilant was a solution of calcium hypochlorite and the medium plain agar. Artificial inoculations were done on nine-month-old cuttings, grown in partially heat-sterilized soil and on 2½-year-old vines in the field. Inoculum consisted of pieces of the fungus growing on rice agar. These were applied to main roots and underground stems, both artificially wounded and intact, and covered with moist cotton-wool and polythene sheet. The young cuttings began to die after 11 days. In the 2½-year-old plants wilting followed by death began after 15–50 days. In this latter experiment the roots and the wounded stems were successfully infected; but the unwounded stems showed slight or no infection. The *Phytophthora* sp. was re-isolated from inoculated plants.

This fungus has been consistently obtained from diseased gardens, which are widespread in the 1st Division, south of Kuching. Isolates have come so far from 26 individual pepper holdings. Observations suggest that infection begins in the fine roots, from which the pathogen has been recovered. Cortical necrosis, the results of attack, spreads into the main roots and thence to the underground stem. When the stem has become infected symptoms become visible above ground. These are: a halt in the growth of the terminal shoots, leaf wilt, rapid leaf yellowing, and fall of leaves and minor branches. Symptoms are fairly uniform over the whole vine. The appearance of above-ground symptoms can be rapid. In a stand of 1,044 vines (1·4 acres), 8·1 per cent were dying in December 1955. Four months later this figure was 80·4 per cent.

The identity of the species is still uncertain since no oospores have been found. Since diseases of the roots and/or the lower parts of the stem in *Piper nigrum* and *P. betle* L. caused by species of *Phytophthora* have been called 'foot-rot' by other workers, it is suggested that this name be used for the Sarawak disease. Hitherto, locally, it has been called 'sudden death'.

We thank the Colonial Office, the Director of the Commonwealth Mycological Institute, and the Director of Agriculture, Sarawak, for permission to publish these results. The work, begun at the instigation of the Sarawak Government, is continuing.

Paul Holliday
Colonial Pool of Plant Pathologists,
Commonwealth Mycological Institute,
Kew.

W. P. Mowat
Pepper Laboratory,
Department of Agriculture,
Sarawak. Dec. 4.

[1] Robertson, N. F., *Commonw. Phytopath. News*, **1**, 20 (1955).
[2] Miller, R. W. R., Ann. Rep. Dept. Agric. Sarawak for 1952, 14 (1953).
[3] Sundararaman, S., Ann. Rep. Dept. Agric. Madras for 1927–28, 355 (1928) (abstract only).
[4] Venkata Rao, M. K., Ann. Rep Dept. Agric. Mysore for 1927–28, 19 (1929) (abstract only).
[5] Krishna Menon, K., *Indian J. Agric. Sci.*, **19**, 89 (1949).
[6] Barat, H., Arch. Rech-agron. Cambodge Laos et Vietnam, 13 (1952).
[7] Muller, H. R. H., Meded. Inst. PlZeikt. Buitenz., 88 (1936).
[8] Thompson, A., *Malay. Agric. J.*, **29**, 245 (1941); and personal communication (Sept. 1956).

A Morphologically Distinct Ecotype of *Dactylis glomerata* L.

Plants of *Dactylis*, both diploid and tetraploid, from the Mediterranean region can be included on purely morphological grounds within the limits of *Dactylis glomerata* ssp. *hispanica* (Roth) Nym. There is only one constant feature of this taxon, described by Domin[1] as follows: "the typical ssp. *hispanica* in one form or another has lemmas divided into two blunt lobes from the middle of which grows a very short awn, or a mere point, which sometimes does not even reach the size of an awn; sometimes the lobes are pointed". Many Mediterranean populations of this broad type have now been studied at Aberystwyth, and among them a form of particular morphological interest has been found.

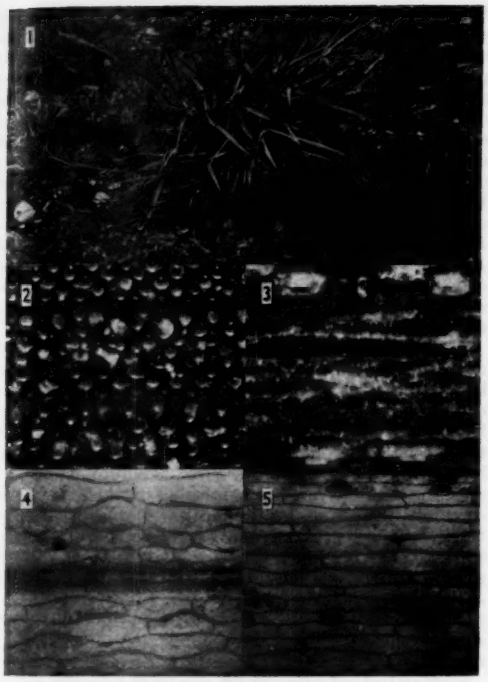
The general appearance of this plant, which often passes under the name of *Dactylis glomerata* "var. *maritima*", is shown in Fig. 1. It is of low-growing habit, quite densely tillering, with short, sometimes broad (up to 1 cm.) and tapering leaves, the flowering heads are compact and ovate, and the culms generally short. The whole plant is typically greyish-green and glaucous.

Table 1. Morphological Characteristics of the Ecotypes: Mean Values based on Twenty-five Plants

Species	Somatic chromosome No.	Locality	Last 3 stem internodes: length*			First 3 panicle internodes: length			No. of panicle internodes	Pedicels of glomeruli	3 basal glomeruli					
											Length			Width		
			1	2	3	1	2	3			1	2	3	1	2	3
Dactylis glomerata "var. *maritima*"	28	Portugal (Nazaré)	76·0	52·0	28·0	6·0	3·0	2·0	8·0	Very short	14·0	—	—	11·0	—	—
Dactylis glomerata ssp. *hispanica* Domin	28	Portugal (Cintra)	318·0	214·0	104·0	12·0	8·0	5·0	11·0	Short	15·0	15·0	10·0	9·0	8·0	8·0

Species	Panicle: length	Flag-leaf			Basal spikelet of lowest glomerulus						
		Length	Upper epidermal cell		Length	No. of florets	Basal lemma				
			Length	Width			Length	Width	Awn length	Notching*	Keel pubescence†
										0 to 3	1 to 3
Dactylis glomerata "var. *maritima*"	26·0	48·0	0·24	0·067	8·2	5	5·6	1·2	0·4	3	3
Dactylis glomerata ssp. *hispanica* Domin	51·0	156·0	0·404	0·041	7·5	4	6·0	1·2	0·8	2	3

* All dimensions in millimetres
† Explanation in text.



Figs. 1-5. 1, 2 and 4. *Dactylis glomerata* "var. *maritima*". 1, Plant × 1/3; 2, upper leaf epidermis × 160, surface view; 4, transmitted light.
3 and 5. *Dactylis glomerata* ssp. *hispanica* (Roth) Nym. 3, Upper leaf epidermis × 160, surface view; 5, transmitted light

In Table 1 the morphological features of a population of this type from Nazaré, Portugal, are compared with those of a population more typical of ssp. *hispanica* from Cintra, Portugal; both are tetraploid.

Among the data, the degree of 'notching' recorded, on a scale of 0–3, indicates the extent to which the lemma apex is characteristic of ssp. *hispanica*. The Nazaré population is prominently of this type. The presence of lemma-keel pubescence was recorded in the manner described by Rebischung[2].

The most important feature of "var. *maritima*" is the epidermal type. Here the cells are wide in relation to their length when compared with those of ssp. *hispanica* (Figs. 4 and 5), and each cell bears a very prominent sub-spherical protuberance from its outer surface, which is absent in ssp. *hispanica* (Figs. 2 and 3). This confers a fine smoothness on all parts of the plant.

In the genus *Dactylis* as a whole, representatives of 151 tetraploid and 11 diploid populations have been examined so far, and, of these, 8 tetraploid populations are of "var. *maritima*", and the remainder of ssp. *hispanica* epidermal type. The form of epidermal cell shown in Figs. 3 and 5 is that usually found in *Dactylis*.

Populations with the distinct "var. *maritima*" epidermal type have been found in southern France, Portugal, Morocco and Majorca, in sandy or base-rich and generally maritime habitats. Their phenotypic characteristics are retained in cultivation and hence are genetically determined.

The occurrence of two distinct epidermal types within a species, as in the present instance in *Dactylis glomerata* L., is unusual among the Gramineæ. Taxonomically the var. *maritima* form should be regarded as an ecotype of ssp. *hispanica* at present, but further genetical and distributional studies, now being pursued, may eventually show that it is an independent sub-species.

MARTIN BORRILL

Welsh Plant Breeding Station,
University College of Wales,
Aberystwyth. Nov. 10.

[1] Domin, K., *Acta Bot. Bohem.*, **14**, 131 (1942).
[2] Rebischung, J., *Ann. Amél. Pl.*, **3**, 346 (1953).

Nature of Chalk Heath Soils

DR. R. M. S. PERRIN'S article on chalk heath soils[1] does not fully explain the occurrences of these formations. His suggestion, that the chalk heaths may be formed on deposits of wind-blown loess-like material over flint pavements, perhaps in the Bronze Age, does not apply to Lullington Heath; for this area, in addition to being a fine example of chalk heath, shows also a very fine example of Celtic field patterns and has been illustrated under the name of Fore Down, Lullington[2]. It is probable that cultivation continued there during the Roman era, for the Britons in Sussex were not driven out or massacred by the Saxons until the third and fourth centuries A.D. Furthermore, traces of human influence are not confined merely to the field patterns; the lumps of iron slag seem to be relics of iron smelting about two thousand years ago, and the sandy patches seem to be relics of military training about fifteen years ago, for remains of the sandbags could be seen until recently.

Much of the land on the South Downs was under cultivation for long periods during the Bronze and Iron Ages. Most of the level patches have again been cultivated in recent years, but there are interesting small patches of heath on the slopes in many places.

Very good examples of these are to be seen on the Old Winchester Hill Nature Reserve, near Petersfield, at the west end of the South Downs. In the north-east corner of the Reserve, there is a large rectangle which has obviously been under cultivation more recently than the surrounding land, perhaps within the past hundred years, as its boundaries are clearly visible in the turf. On the brow of this hill—angle of slope 10° and compass bearing 256°—there are some small patches of *Calluna vulgaris*. There are several other patches on gentler and steeper slopes, facing generally towards the south-west, on the less recently disturbed parts of the same hill: slope 7°, compass bearing 212°; slope 17°, compass bearing 217°; slope 10°, compass bearing 222°; slope 7°, compass bearing 224°; slope 7°, compass bearing 232°; slope 20°, compass bearing 253°.

The Iron Age camp, probably constructed in the first century B.C., is on a spur running westwards, the oval ramparts enclosing the rounded crown of the hill. There is little *Calluna* on the slopes facing northwards, although an abundance of *Potentilla erecta* denotes acid surface soil in places. But there are many patches of *Calluna* on the south-facing slope. One of the largest, a continuous stretch 30 ft. long, is on a slope of 8° with a compass bearing of

198°. Finally, there is a remarkable patch of *Calluna* on the embankment itself, the slope being 33° and the compass bearing 203°; the slope must have been steeper when this embankment was built out of chalk rubble.

It seems, therefore, that chalk heaths may arise not merely on plateaux but also on slopes, especially those facing the prevailing south-west winds, and that they may be found on places which must have been under cultivation about two thousand years ago, or about fifteen hundred years ago, or even more recently. The shallow undisturbed soils would be porous through the growth and decay of plant roots and through the activities of burrowing insects and other small animals. If the calcium ions have moved down through the soil in solution by the rain, is it not possible also that the finer soil particles, less than 0·03 mm. in diameter, may have moved down in suspension? May not the physical composition of the soil, as well as its chemical composition, be due to leaching rather than to deposition? Is sorting and deposition by water ruled out? Did solifluxion (as this term is now generally used) cease at the end of the Pleistocene?

It is hoped to write an account of the relict heath patches on the South Downs and in other chalk areas of south England, for the *Calluna* is now becoming obvious in places where formerly it was closely grazed by rabbits.

A. S. Thomas

Nature Conservancy,
19 Belgrave Square,
London, S.W.1.

[1] Perrin, R. M. S., *Nature*, **178**, 31 (1956).
[2] Curwen, E. C., "The Archæology of Sussex", 212 (1954).

The object of the work reported in my previous communication was simply to determine whether the soils on some well-developed chalk heaths could have been formed purely by solution of chalk. The areas chosen were Old Winchester Hill, Butser Hill, Manor Farm Down and Lullington Heath, since they appeared to conform to Tansley's original definition of chalk heath and in each case the association was well established in spite of heavy rabbit-grazing.

Since all the soils that have so far been examined lie on sharp crests or gentle slopes adjacent to steep slopes, it is very probable that they would have been left as bare chalk surfaces at the end of the Pleistocene. Now combination of analyses of chalk drainage waters with percolation data can give a rough estimate of the maximum probable rate of accumulation of chalk residues since that time. It is found that, although on some sites the depth of soil is fortuitously consistent with the calculated rate of formation, in other areas (for example, Old Winchester Hill) it appears to be too great. If, as suggested by Dr. Thomas, solifluxion did not cease at the end of the Pleistocene, it is even less likely that chalk residues would have accumulated to the observed soil-depth.

Consideration of the relief of these sites and of the geomorphological history of the South Downs shows that deposition by water is very unlikely to have occurred since Upper Pliocene or Lower Pleistocene times. Such deposits, if they ever existed, would have been very susceptible in these exposed situations to the subsequent peri-glacial conditions.

Apart from the mineralogical composition of the sand fractions, which seems to show conclusively that the soils are not derived from chalk, it is difficult to see how the observed degree of mechanical sorting could be caused by leaching of chalk residues. There is no reason why movement should commence with particles of 30μ diameter, and the eluviation of fine sand and silt particles, which are not even of colloidal dimensions, is scarcely to be compared with that of calcium ions in true solution. Mechanical eluviation in soil profiles is probably confined to dispersed colloids of less than 0·1μ equivalent settling diameter. Even this type of movement does not appear to occur in chalk heath soils, since there is no textural *B* horizon in either the solum or the underlying chalk. Analogy with other leached soils overlying chalk or calcareous drifts indicates that if such a horizon existed it would be found resting sharply on the calcareous surface.

The simplest explanation that fits all the facts is that the development of acidity in these soils has been facilitated by blanketing with wind-borne dusts carrying relatively small amounts of $CaCO_3$. This hypothesis is supported by the close resemblance of the mechanical composition curves to those of typical loesses in, for example, France, Belgium, Germany and the United States. Material of this type was certainly deposited in Britain early in Post-Glacial time, and preliminary analyses of soils from earthworks on the Chalk suggest that deposition continued even after the Bronze Age. It might perhaps still occur to-day in exceptionally dry, windy seasons. It is, of course, quite possible that an originally wind-sorted material may later have been locally redeposited by water as hill-wash.

Cultivation clearly could not significantly affect the mechanical and mineralogical compositions of the sand fractions. Apart from turning up chalk, and so locally delaying the onset of acidity, its main effect would be to accentuate colluviation and thus lead to the deepening of the soils on the lower sides of fields. It is quite likely that on such soils chalk heath might develop more easily, as suggested by Dr. Thomas. The fact remains, however, that these soils cannot be considered to result from the solution of chalk.

R. M. S. Perrin

School of Agriculture,
Cambridge.

Identification of Coffinite in Radioactive Rocks of the Buller Gorge Region, New Zealand

Coffinite, the recently discovered hydroxy-uranous silicate, $U(SiO_4)_{1-x}(OH)_{4x}$[1], has been identified as an essential primary constituent of radioactive arkosic grits and siltstones of the lower Cretaceous Ohika Group[2] in the Buller Gorge region of the South Island of New Zealand. The identification is based on the characteristic X-ray pattern with lines at 4·68, 3·48, 2·66 and 1·78, and on the absence of thorium[1,3]. Fuller details will be published elsewhere.

J. J. Reed
N.Z. Geological Survey,
Wellington, New Zealand.

G. G. Claridge
Soil Bureau,
Wellington, New Zealand.

Dec. 12.

[1] Steiff, L. R., Stern, T. W., and Sherwood, A. M., *Science*, **121**, 608 (1955).
[2] Wellman, H. W., *N. Z. J. Sci. Tech.*, **32**, B (No. 3), 11 (1950).
[3] Weeks, A. D., and Thompson, M. E., *U.S. Geol. Surv. Bull.*, **1009** B, 31 (1954). Gruner, J. W., U.S. Atomic Energy Comm. Tech. Inf. Service, Oak Ridge, Tenn., *RME*-3020, 16 (1955).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 11

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at 14 Belgrave Square, London, S.W.1), at 5.30 p.m.—Mr. A. P. Hosking and Mr. K. C. Salter: "A Survey of Industrial Filtration".

UNIVERSITY OF LONDON (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. Cuvillier (Paris): "Modern Micropalæontology".* (Further lectures on March 12 and 14.)

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, London, W.C.2), at 6 p.m.—Discussion on "Simple Approaches to the Understanding of Commutation".

INSTITUTION OF MECHANICAL ENGINEERS, LONDON GRADUATES' SECTION (joint meeting with the LONDON GRADUATES' SECTIONS of the INSTITUTIONS OF CIVIL and ELECTRICAL ENGINEERS, at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 6.30 p.m.—Sir Josiah Eccles: "Sources of Power".

Tuesday, March 12

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. R. Bradshaw: "Leonardo da Vinci—Geologist".*

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens' Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at 6 Buckingham Gate, London, S.W.1), at 5.30 p.m.—Mr. F. Lee: "Slip Clutches and Mechanical Safety Devices".

INSTITUTION OF ELECTRICAL ENGINEERS (in conjunction with the BRITISH NUCLEAR ENERGY CONFERENCE, at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. J. R. MacLusky: "An Analogue Computer for Nuclear Power Studies" and "The Application of Analogue Methods to Compute and Predict Xenon Poisoning in a High Flux Nuclear Reactor".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. A. A. Appleton: "Petroleum as a United Kingdom Source of Raw Material for Synthetic Rubber"; 7 p.m.—Prof. M. Stacey, F.R.S.: "Fluorinated Elastomers".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. Frey-Wyssling (Zürich): "Macromolecules in Cell Structure".* (Further lectures on March 13 and 15.)

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. E. R. Gadd: "High Temperature Materials for Engines".

Wednesday, March 13

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Mr. M. V. Murray: "The Work of B.C.U.R.A. on the Coking Stoker".*

UNIVERSITY OF LONDON (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. A. Linder (Geneva): "Some Problems in Applied Statistics, Solved and Unsolved".* (Further lecture on March 15.)

MALACOLOGICAL SOCIETY OF LONDON (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Discussion on "The Gastropod Shell". Chairman: Prof. Alastair Graham. Opening Speakers: Dr. L. R. Cox, F.R.S., Dr. A. Comfort and Dr. D. R. Crofts.

REINFORCED CONCRETE ASSOCIATION (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. F. S. B. Jacobson: "Reinforced Concrete Problems on the Gold Coast".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the MICROBIOLOGY GROUP, at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. L. F. L. Clegg: "The Production of Sterilized Milk".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at the Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1), at 7 p.m.—Mr. N. Parr: "Zone Purification and its Application to Silicon".

Thursday, March 14

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 11 a.m.—Discussion on "The Cytoplasm in Variation and Development"; opened by Prof. D. G. Catcheside, F.R.S.

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. I. M. James: "The Vector-field Problem".

CHEMICAL SOCIETY (in the Lecture Theatre of the Royal Institution, Albemarle Street, London, W.1), at 7.30 p.m.—Prof. H. C. Urey: "Chemical Problems Relating to the Origin of the Earth".

BRITISH INSTITUTE OF RADIOLOGY AND RÖNTGEN SOCIETY (at 32 Welbeck Street, London, W.1), at 8 p.m.—Prof. P. M. S. Blackett, F.R.S.: "The Elementary Particles of Nature" (Thirty-sixth Silvanus Thompson Memorial Lecture).

Friday, March 15

SOCIETY FOR WATER TREATMENT AND EXAMINATION (in the Library, Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 9.30 a.m.—Annual General Meeting, followed by Dr. R. S. Ingols: "Ozone"; and a Symposium on "Taste and Odours in Water".

INSTITUTION OF MECHANICAL ENGINEERS, LUBRICATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Factors in the Handling of Lubricants".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. E. B. Ford, F.R.S.: "The Study of Evolution by Observation and Experiment".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DAIRY CHEMIST (with an honours degree in chemistry and preferably experience of dairy chemistry) IN THE DAIRYING DEPARTMENT (at Auchincruive), for investigational work and the supervision of routine analyses—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (March 15).

PHYSICIST or ELECTRICAL ENGINEER (graduate) to supervise the operation and development of the Nuffield cyclotron—The Physics Department, The University, Birmingham 15 (March 16).

LECTURER (man or woman) IN APPLIED MATHEMATICS—The Principal, Royal Holloway College, Englefield Green, Surrey (March 18).

LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Registrar, The University, Liverpool (March 23).

LECTURER (with special qualifications in sedimentary petrology) IN GEOLOGY; a LECTURER (with special qualifications in algebra and/or geometry) IN PURE MATHEMATICS; ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF MATHEMATICS; and a LECTURER (with special qualifications in human geography) IN GEOGRAPHY—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (March 23).

FARM DEMONSTRATOR (with a degree in agriculture, or an honours degree in pure science followed by an adequate postgraduate qualification in agriculture together with farming experience) at the School of Agriculture—The Secretary, School of Agriculture, The University, Cambridge (March 25).

RESEARCH FELLOW IN MATHEMATICS—The Secretary of University Court, The University, Glasgow (March 25).

ASSISTANT LECTURER (specialist in applied mathematics) IN THE DEPARTMENT OF MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 30).

KEEPER (with a university degree in geology or the Diploma of the Museums Association) OF THE DEPARTMENT OF GEOLOGY in the Leicester Museums—The Director, Museums and Art Gallery, New Walk, Leicester (March 31).

PROFESSOR OF AGRICULTURAL BACTERIOLOGY; and a PROFESSOR OF ENTOMOLOGY—The Dean of the Faculty of Agriculture, McGill University, Macdonald College, Quebec, Canada (March 31).

RESEARCH FELLOWS (Ph.D. standard, with a special aptitude for research in high or low energy nuclear physics) IN EXPERIMENTAL or THEORETICAL NUCLEAR PHYSICS—The Registrar, The University, Liverpool (April 1).

LECTURER IN MATHEMATICS—The Secretary, University College, Cork (April 6).

STATISTICIAN (BIOMETRICIAN); an ASSISTANT SYLVICULTURIST; and an ASSISTANT ENTOMOLOGIST, at the Wattle Research Institute of the University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, April 6).

READER IN APPLIED MATHEMATICS at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 9).

ASSISTANT LECTURER IN PHYSICS at Makerere College (The University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 10).

SENIOR LECTURER IN PHYSIOLOGY at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (April 12).

SENIOR LECTURER or LECTURER IN THEORETICAL MECHANICS at the University of Khartoum—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (April 12).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (April 13).

BOTANISTS (with at least a second-class honours degree with botany as the main subject, and two years postgraduate research experience in plant breeding) with the Rubber Research Institute of Malaya, Kuala Lumpur, Federation of Malaya, to engage in a research programme relating to the improvement of planting material of *Hevea brasiliensis*—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7 (April 15).

LECTURER IN CHEMISTRY in the Department of Biochemistry and Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (April 18).

LECTURER IN GEOGRAPHY—The Registrar, Trinity College, Dublin (April 18).

LECTURER or ASSISTANT LECTURER (preferably qualified in physical chemistry) IN CHEMISTRY—The Secretary and Registrar, The University, Southampton (April 20).

RESEARCH FELLOW IN METABOLIC DISEASES OF SHEEP in the Faculty of Rural Science, to undertake research on pregnancy toxæmia and carbon tetrachloride poisoning of sheep—The Registrar, University of New England, Armidale, New South Wales, Australia (April 30).

ANALYST (with a good honours degree in chemistry, preferably with suitable postgraduate experience or training) at the West African Cocoa Research Institute, Gold Coast, to carry out routine chemical analyses—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.197/200/020.

ASSOCIATE or ASSISTANT PROFESSOR IN THE DEPARTMENT OF PHARMACOLOGY—Prof. K. I. Melville, Chairman, Department of Pharmacology, McGill University, Montreal, P.Q., Canada.

DEMONSTRATORS (2) IN INORGANIC CHEMISTRY—The Registrar, The University, Nottingham.

EDITOR (chemist, with some editorial experience, and interested in the development of a leading weekly periodical) OF *Chemistry and Industry*—The General Secretary, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1, marking envelope "Personal".

LECTURER (with a good honours degree) IN CHEMISTRY—The Acting Principal, School of Technology, Tower Ramparts, Ipswich.

LECTURER (with some postgraduate training) IN THE DEPARTMENT OF PHYSICS—Prof. A. D. Misener, Department of Physics, University of Western Ontario, London, Ontario, Canada.

PHYSICIST/ELECTRICAL ENGINEER (with a first- or second-class honours degree in physics or electrical engineering, and at least three years postgraduate research experience) at the Ministry of Supply Proof and Experimental Establishment, Shoeburyness, Essex, to lead a section engaged on the development of methods of ballistic measurement—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.67/7A.

PROFESSOR AND HEAD OF THE DEPARTMENT OF CHEMICAL ENGINEERING—Dean H. C. Gunning, Faculty of Applied Science, University of British Columbia, Vancouver 8, B.C., Canada.

PROFESSOR OF PHILOSOPHY—The Principal, St. David's College, Lampeter, Cardiganshire.

RESEARCH ASSISTANT (with H.N.C. in chemistry or equivalent, able to construct and manipulate laboratory research apparatus, and some knowledge of chemical analysis) IN THE CHEMISTRY DEPARTMENT in London, to join a research team investigating iron and steel manufacturing problems by physico-chemical techniques—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "C.P.6".

RESEARCH OFFICER (with a university degree in forestry, or a university degree in botany and a diploma in forestry) IN THE DEPARTMENT OF FOREST RESEARCH, Federation of Nigeria, to carry out sylvicultural investigations, chiefly in the high forest regions of the Federation but with a possibility of work in the savannah regions also, and occasional instructional duties at the Forest School—The Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.61/14/06.

RESEARCH PHYSICIST to join a small group engaged in studies of solids and liquids by neutron diffraction techniques and in low temperature studies—File 2C, Atomic Energy of Canada Limited, Chalk River, Ontario, Canada.

RESEARCH SCHOLAR (with an honours degree in chemistry or equivalent qualifications)—The Registrar, University College, Leicester.

SCIENTIFIC OFFICERS (CHEMISTS) IN THE METROPOLITAN POLICE LABORATORY—The Secretary, Room 165 (S), New Scotland Yard, London, S.W.1.

SENIOR SCIENTIFIC OFFICER/SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or metallurgy or equivalent qualifications, and preferably experience in metallic coatings or related subjects), for research and development work in electro-deposition of metals (Ref. 1428/34); and a SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or metallurgy or equivalent qualifications), for investigation in the field of metallic corrosion (Ref. 1429/34)—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting appropriate Ref. No.

TAXONOMIST (with a degree in botany or agricultural botany, and preferably research experience in taxonomy or plant physiology) at the Official Seed Testing Station for England and Wales—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Transactions of the Royal Society of Edinburgh. Vol. 63, Part 1 (No. 9): The Vascular Architecture of the Rat Uterus during Pregnancy. By A. Young. Pp. 167–184+8 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1956.) 10*s.* 6*d.* [111

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 964, Vol. 249 (18 December 1956): The Flow of Cohesionless Grains in Fluids. By R. A. Bagnold. Pp. 235–298+plate 2. (London: Royal Society, 1956.) 22*s.* [111

The National Gallery, January 1955–June 1956. Pp. 105+12 plates. (London: National Gallery, 1956.) 10*s.* [111

Monotype Corporation Limited. The Monotype Recorder, Vol. 40, No. 4: Setting Mathematics, with a Glossary of Mathematical Terms and Nomenclature of Signs. By Arthur Phillips. Pp. 32. "Monotype" Mathematical Sorts List. Selected and Compiled by Arthur Phillips. Pp. 40. (London: Monotype Corporation Limited, 1956.) [111

J. H. Fenner and Co. (Holdings), Ltd. Annual Report, 1956. Pp. 24. (Hull: J. H. Fenner and Co. (Holdings), Ltd., 1956.) [111

British Museum (Natural History). Instructions for Collectors. No. 10: Plants. Sixth Edition. Pp. 72. (London: British Museum (Natural History), 1957.) 2*s.* [111

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Ross Institute Industrial Advisory Committee Bulletin No. 4 (Re-written November 1956): Tropical Ulcer. Pp. 12. (London: London School of Hygiene and Tropical Medicine, 1956.) [111

National Museum of Wales. Forty-ninth Annual Report, 1955–56. Pp. 77+4 plates. (Cardiff: National Museum of Wales, 1956.) [111

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 671, Vol. 240 (3 January 1957): The Nervous Anatomy of the Body Segments of Nereid Polychaetes. By J. E. Smith. Pp. 135–196. (London: Royal Society, 1957.) 19*s.* [111

Year Book of the Physical Society, 1956. Pp. vi+76. (London: Physical Society, 1956.) [111

Science and the Humanities. By Sir Gavin de Beer. (The Rickman Godlee Lecture delivered at University College, London, 25 October 1956.) Pp. 21. (London: H. K. Lewis and Co., Ltd., 1956. Published for University College, London, and University College Hospital Medical School.) 2*s.* 6*d.* net. [111

Institute of Fuel. Special Study of Domestic Heating in the United Kingdom—Present, and Future. Vol. 2. (Proceedings of the Conference, 1956, including certain papers received too late for inclusion on Vol. 1.) Pp. 106. (London: Institute of Fuel, 1956.) [111

British Medical Bulletin, Vol. 13, No. 1: Physiology and Pathology of the Kidney. Pp. 74+12 plates. (London: British Council, 1957.) 20*s.* [111

Linen Industry Research Association. Report of the Council, 1956. Pp. 20. (Lambeg: Linen Industry Research Association, 1957.) [111

Metropolitan Water Board. Thirty-sixth Report on the Results of the Bacteriological, Chemical and Biological Examination of the London Waters for the years 1953–1954. By Dr. E. Windle Taylor. Pp. 74+3 plates. (London: Staples Press, Ltd., 1956.) 15*s.* 6*d.* [111

Aero Research Technical Notes. Bulletin No. 167: "Araldite" Electrical Insulation. Pp. 6. (Duxford: Aero Research Limited, 1956.) [111

The Art of Lecturing—Some Practical Suggestions. By Dr. G. Kitson Clark. Pp. ii+20. (Cambridge: W. Heffer and Sons, Ltd., 1957.) 1*s.* 6*d.* net. [111

The Night Sky 1957. Pp. 26. (London: The Times Publishing Company, Ltd., 1957.) 3*s.* net. [111

Other Countries

Chicago Natural History Museum. Fieldiana: Zoology. Vol. 34, No. 41 (November 13, 1956): Geographic Variation in the Chicken Turtle *Deirochelys reticularia* Latreille. By Albert Schwartz. Pp. 461–504. (Chicago: Chicago Natural History Museum, 1956.) 85 cents. [111

Indian Association for the Cultivation of Science. Annual Report for 1955–56. Pp. 81. (Jadavpur, Calcutta: Indian Association for the Advancement of Science, 1956.) [111

FAO Nutrition Meetings Report Series No. 13: Report of an International Seminar on Education in Health and Nutrition, Baguio, Philippines, 13 October–3 November 1955. By F. W. Clements. Pp. vii+92. (Rome: Food and Agriculture Organization of the United Nations; London: H.M. Stationery Office, 1956.) 5*s.*; 1 dollar. [111

Publications de l'Institut National pour l'Étude Agronomique du Congo Belge. Série Scientifique No. 68: Le Déterminisme de l'Evaporation dans la Nature: Étude des Aspects Géophysique et Écologique du Problème dans le Cadre du Bilan Énergétique. Première partie: Généralités Théoriques. Par Étienne A. Bernard. Pp. 162. (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1956.) 135 francs. [111

Publications of the Kapteyn Astronomical Laboratory at Groningen. No. 58: Electronic Scanning for Variable Stars. By J. Borgman. Pp. 35. No. 59: Distribution in Space of the K Giants near the Sun. Relation of the Space Densities of the A Stars and the K Giants to the Spiralarms. By P. J. Van Rhijn. Pp. 31. (Groningen: Kapteyn Astronomical Observatory, 1956.) [111

Carnegie Institution of Washington. Report of the President, Pp. 28. (Washington, D.C.: Carnegie Institution of Washington, 1956.) [111

American Association for the Advancement of Science. General Program–Directory of the Seventh New York Meeting (The 123rd Meeting of the Association—The Annual Meeting for the year 1956.) Pp. 400. (Washington, D.C.: American Association for the Advancement of Science, 1956.) [111

Commonwealth Scientific and Industrial Research Organization. Leaflet Series No. 15: Saving Water in Dams: The Mansfield Process. Pp. 4. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [111

United States Department of Agriculture. Home and Garden Bulletin No. 53: Lawn Insects: How to Control Them. Pp. 24. (Washington, D.C.: Government Printing Office, 1956.) 15 cents. [111

Zoology Publications from Victoria University College. No. 20: Keys and Bibliography to the Collembola. By J. T. Salmon. Pp. 35. (Wellington, N.Z.: Victoria University College, 1956.) [111

Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Eighth Annual Report for the year ending 30th June, 1956. Pp. vi+400. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1956.) [111

A Manual for Coding Organic Compounds for use with a Mechanized Searching System. By T. R. Norton and A. Opler. Pp. ii+56. A Manual for Programming Computers for use with a Mechanized System for Searching Organic Compounds. By A. Opler and T. R. Norton. Pp. i+23. (Midland, Michigan: The Dow Chemical Company, 1956.) [111

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

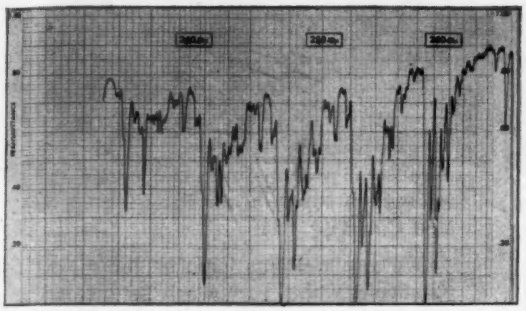
Annual subscription £7/10/–, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T. G. Scott & Son, Ltd., 1 Clement's Inn, London, W.C.2
Telephone Number: Holborn 4743

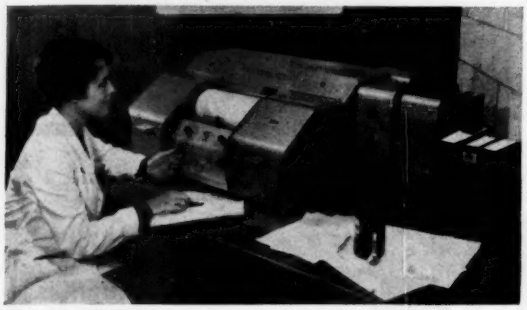
All rights reserved. Registered as a newspaper at the General Post Office

SPECTRACORD* 4000 Spectrophotometer

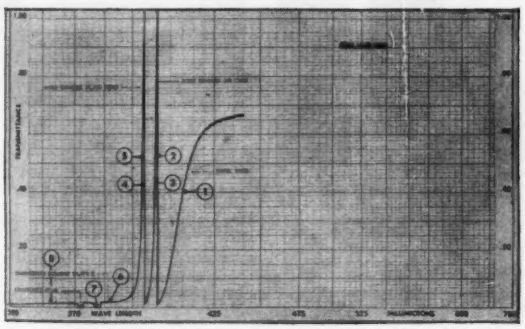
for the ultraviolet, visible and near infrared



High resolution is illustrated by the benzene vapor spectrum above. Instrument resolving power: **1** Å at 2500 Å; **2** Å at 4000 Å; **20** Å in the near infrared.



Fast, Simple Operation:
Twice as fast as any other instrument at comparable resolutions.



Low scattered light of the instrument is illustrated by the above sodium nitrite run. (1) actual transmission of sodium nitrite at 0-100 T scale. (2) Scale expanded to read 1% T full scale. (3) Run continued with expanded scale. (4) Scale expanded to read 0.01% T full scale. (5) Same as (3). (6) Transmission of sample 0.0002% T. Sample beam closed to show true zero. (8) Transmission stray light now 0.0001%.

The runs shown at left illustrate the unusual precision of the SPECTRACORD 4000 spectrophotometer. This laboratory instrument provides performance equivalent to considerably more expensive instruments, and at a price comparable to the least expensive spectrophotometers of limited operations. Design features of the SPECTRACORD 4000 instrument include:

- double monochromator for high resolution with virtually no scattered light. Superior to single monochromator for qualitative and quantitative analysis.
- drum-type recorder for greatest accuracy. Constant, even contact between pen and paper insures high reproducibility.
- linear absorbance and transmittance recording for increased analytical flexibility.
- plug-in electronic units for fast, easy searching.
- time-drive and repetitive scanning accessories for your special analytical problems.
- a variety of recorder papers for the different wave-length ranges.
- speedy change-over from one recording range to another.
- single and double beam operation for spectral energy or transmittance recording.

The SPECTRACORD 4000 instrument, because of its versatility, simplicity and low cost has broad application in petroleum, food, drug, medical, agricultural, paint, plastics, glass, packaging, sewage and paper industries. Send for more complete information covering your particular application.

*Trade Mark

INSTRUMENT DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT

PHASE CONTRAST ILLUMINATION

A booklet fully describing the Beck Phase Contrast Illumination Apparatus will be forwarded on application

R & J BECK LTD

69 MORTIMER STREET
LONDON W.1

BECK LONDON

Eyepiece and Stage MICROMETERS

We now have over 40 different patterns of Eyepiece and Stage Micrometers—all normally available from stock.

Included in this range are crosslines, crossed scales, grids, scales of varying lengths, concentric circles, not forgetting 6 different patterns for dust counting and calibration based on the Patterson Globe and Circle.

We also welcome inquiries for special Graticules where, particularly for quantity requirements, our price for quality is unmatched.

Write for latest list to :

Graticules LIMITED

57–60 HOLBORN VIADUCT, LONDON, E.C.1
Phone: CENtral 2717/8 Grams: Rheinberg, Cent., London

GREEN'S

PURE FILTER PAPERS

WE HAVE MADE GREEN'S PURE FILTER PAPERS SINCE 1915

Write at once for descriptive catalogue NG55 which contains charts of ash, comparative tables and 40 pages of information, vitally interesting to all chemists.

J. BARCHAM GREEN LTD.
MAIDSTONE, ENGLAND

D-845 Industrial Weston Reference Cell

The D-845 Industrial Reference Cell is confidently recommended for use as an accurate and stable source of e.m.f. The reference cell is of the unsaturated acid type with cadmium-mercury amalgam contained in the negative limb and mercury together with a layer of mercurous sulphate contained in the positive limb. The electrolyte which almost completely fills the remainder of the interior consists of an unsaturated acid solution of cadmium sulphate.

This cell will function under widely varying temperature conditions—be tolerant to a wide range of mounting positions—withstand rough handling and yet maintain an accurate and stable reference voltage. Mounted and unmounted types are available from stock.

Write for Publication 5739.

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND

Phone: Beckenham 0041 Grams & Cables: MUIRHEAD BECKENHAM

Printed in Great Britain by FISHER, KNIGHT & CO., LTD., The Gainsborough Press, St. Albans, and published by MACMILLAN & CO., LIMITED, at St. Martin's Street, London, W.C.2, and ST. MARTIN'S PRESS, INC., 103 Park Avenue, New York 17, N.Y., U.S.A.—Saturday, March 9, 1957.

57

.C.1
ndon

45